SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS

JULY 1912.

GENERAL PHYSICS.

982. ***Density of Solid Substances with Especial Reference to Permanent Changes produced by High Pressures.*** **J. Johnston and L. H. Adams.** (Amer. Chem. Soc., Journ. 84. pp. 568–584, May, 1912.)—A new form of pyknometer has been designed capable of determining the density of solids to within 0·02 per cent. Powdering a homogeneous crystalline substance free from unsoundness does not affect its density. The application of very high hydrostatic pressure has no permanent effect on the density of homogeneous crystalline materials. On metals the effect of pressure is first to increase the density owing to closing-up of pores, &c., after which the density decreases, sometimes to below the original value. Subsequent annealing increases the density. Contrary to the observations of Spring, it was found that bismuth decreases in density after deformation. A comparison of the data obtained with the phenomena observed by Beilby indicates that the amorphous phase is similar to an undercooled melt. The result of deformation, therefore, should be to produce a change of density in the same direction as that produced on fusion, and this is found to be the case with all metals except bismuth. F. C. A. H. L.

983. ***Immersion Areometer.*** **A. Berget.** (Comptes Rendus, 154. pp. 1294–1296, May 13, 1912.)—The buoyancy of a cylindrical glass vessel, which is partly filled with mercury, is opposed by a spiral spring of invar tape, which is attached to the end of the float; the spring acts as dynamometer, and its length is measured with the aid of a cathetometer. Experiments made with salt solutions of almost the same density show that the instrument is exceedingly sensitive; it is recommended for continuous dilatation determinations. H. B.

984. ***Registering Bathy-rheometer.*** **Y. Delage.** (Comptes Rendus, 154. pp. 954–959, April 15, 1912.)—The problem of the measurement of surface currents can be solved in a sufficiently exact manner; but for the measurement of deep ocean currents, oceanographers do not appear to possess an apparatus suitable for recording their direction and velocity. In the present paper an instrument is described which will record the direction and the velocity of such currents. It consists essentially of a hollow sphere of copper, about 0·5 m. in diam., whose mean density (including the apparatus inside) is less than that of water, so that when immersed the water exerts on it an upward force, which can be varied at will by means of discs of lead acting as ballast and situated inside the sphere. This sphere is connected by a bar of copper to a sort of sledge made of wood, heavily weighted to keep it at the bottom of the sea. The union of the bar with the sphere is rigid; that of the bar with the sledge consists of a Cardan joint allowing the sphere to be displaced in all azimuths, but not allowing of any rotation of the sphere about its axis, *i.e.*, about the bar which supports it. If we imagine that inside the sphere, at a point diametrically opposed to that at which it is attached to the bar, a pendulum is suspended, it is easy to see that, when the sphere is inclined under the pressure due to a current, the pendulum, remaining vertical, will make with the axis of the sphere an angle which will be a function of the velocity of the current. Moreover, the direction of the current will be in the plane determined by the axis of the sphere and the bar of the pendulum. The sledge is slowly drawn along the ocean-bed by a cable attached to an anchor which is trailed behind the boat in a known direction. The direction of the current is given with reference to this known direction. Its velocity is given by the graduations of the instrument. For particulars of the recording apparatus and special features the original paper should be consulted. *Errata* (Ibid. p. 1124, April 22, 1912). A. W.

985. *Distribution of Deformation in Metals under Stress.* **L. Hartmann.** (Comptes Rendus, 154. pp. 584–586, Feb. 26, 1912.)—A cylindrical tube of brass 70 mm. in external diam., 1 mm. thick, and 60 mm. long, when compressed longitudinally buckles in a series of folds. Each fold is divided into four segments of straight lines slightly rounded at the ends. The segments of adjacent folds alternate so that the whole gives an octagonal projection on a plane normal to the axis. The folds are united by ribs so that if the cylindrical surface be considered to be smoothed out and developed, it appears marked with a network of contiguous hexagons. The number of segments in each fold depends on the nature of the metal, the dimensions, and the nature of the compression plate surfaces. The folds do not form simultaneously. At first the whole surface shows slight circular swellings; the end swellings then accentuate themselves till one stops growing and the other becomes polygonal, the process finishing with the completion of the fold: the phenomenon is gradually completed along the tube. The cases are described: of tubes of square and elliptical sections; of a tube on a mandril; of one closed at the ends and filled with liquid, and of a series of hollow zones of hemispheres. In all cases the deformations are quite independent of the nature of the growth of load even if it is a blow. The growth of the deformations was recorded cinematographically. C. A. M. S.

986. *Distribution of Deformation in Metals under Stress.* **C. Fremont.** (Comptes Rendus, 154. pp. 1081–1082, April 22, 1912.)—The author sets out a theory to explain the phenomenon of the wave-like flexure of thin tubes subjected to compression. Compression makes the generators of the cylinder tend to shorten and to move away from the axis. End friction retards the diametral expansion locally, causing the generators to bend at the end in circular arcs. The end only whose resistance is the lower continues to

deform. Compression makes the ends of the arc approach each other, the arc being forced out as a wave or swelling, and the end not restricted by friction is bent inwards by reaction. The next wave now forms, not at the other end of the tube, but in contact with the first, since the metal is there overstrained and offers less resistance. An accidental flaw or want of homogeneity disturbs the regular phenomena, causing secondary markings which may be of regular form, or may simply crumble the surface. [See preceding Abstract.] C. A. M. S.

987. *Wave-impact on Engineering Structures.* **A. H. Gibson.** (Inst. Civ. Engin., Proc. 187. pp. 274–291, 1911–1912.)—The failure of a breakwater, formed of blocks of masonry or concrete, under wave-impact, is usually initially due to undermining or settling of the foundations, or to the displacement of some one or more of the face-blocks, thus permitting free access to the interior of the mass. If water accumulates in the interior of a breakwater and is in communication with the sea-face through one or more crevices or open joints which are themselves full of water, the face-pressure due to wave-impact may be transmitted hydrostatically to every portion of the interior. Moreover, as all portions of the face may not be exposed to direct impact at the same instant, this can give rise to an internal pressure tending to cause outward displacement of the blocks, and this pressure may attain an effective value of about 6400 lbs. per sq. ft. This effect has been experimentally investigated. The main conclusions to be drawn from the investigation are that while, on the assumption of simple hydrostatic transmission of pressure, the effective internal pressure due to wave-impact cannot exceed that exerted by wave-impact on the sea-face of a breakwater, the pressures produced, if the energy of the wave is devoted to compression of the air in the open joints, may amount to approximately twice this magnitude. If, however, conditions are favourable to the production of water-hammer action, considerably greater internal pressures, up to some fifteen times the face-pressure with very high velocities of impact, are to be regarded as possible. The results are then considered as affecting the design of a sea-wall or breakwater. A. W.

988. *The Deflection of an Encastré Beam.* **Lecornu.** (Comptes Rendus, 154. pp. 1269–1271, May 13, 1912.)—The ordinary formula for the end deflection f of a cantilever is $f = \mathrm{P}l^3/3\mathrm{EI}$. Clebsch modifies the formula to read $f = (\mathrm{P}/\mathrm{EI})(l^3/3 + cl)$. Here $\mathrm{P} =$ end load, $l =$ length of free cantilever, $\mathrm{E} =$ modulus of elasticity, $\mathrm{I} =$ moment of inertia of section, $c =$ a constant depending on the form of section, but always small. The author shows that c may be neglected provided the encastration is so defined that the mean fibre is always horizontal at the support, and horizontal slipping of the fibres is not impeded. This is consistent with the usual method of embedding, and accordingly the simpler formula may safely be used.

C. A. M. S.

989. *Law of Similarity in Fluid Friction Phenomena.* **H. Blasius.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 639–648, April 20, 1912.)—The author criticises adversely Nusselt's derivation of the Reynolds' law in the special form $c = a(vl/\nu)^n$. Phenomena where this law holds are: pressure drop in tubes, surface friction and pressure on plates, and immersed bodies in a fluid without free surface, *e.g.*, a balloon in air. In all these cases the coefficients in the equations are functions of vl/ν (the Reynolds number).

Thus corresponding speeds here are inversely as the lengths, and not, as in gravitational phenomena, directly as $\sqrt{l}$. When different liquids or changes of temperature are involved ν is important. Disregarding the compressibility of air, which may be ignored at ordinary speeds, air differs from water only in specific gravity and viscosity, *i.e.*, it satisfies these conditions of similarity. With fluids of small ν a high Reynolds number may be realised with small models or at low speeds. Thus it is advantageous to conduct balloon model experiments in water because ν_{water} is $\frac{1}{10}$ to $\frac{1}{15}$ of ν_{air}. Mercury, carbon disulphide, ether, and methyl alcohol have still smaller ν and are for similar reasons highly suited dynamically for model experiments. In problems where friction and gravitation occur together these laws may not be applied without restriction, because $v^2/2gl$ and vl/ν must increase together in the same ratio for model and ship. The author applies the principles of similarity to pipe flow and discusses the coefficient λ in the usual formula $h = \lambda \,.\, l/d \,.\, 22/2g$. λ must be a function of vd/ν. Thus a large number of experimental results are plotted; $\log \lambda = \log (2gdh/v^2l)$ as ordinate and $\log (vd/\nu)$ as abscissa. If the law of similarity holds, all experimental values for varying diams. and speeds should fall on one curve. The exhaustive experiments of Saph and Schoder on drawn brass tubes (Amer. Soc. Civ. Engin., Proc. p. 253, 1903) are plotted in this way, and the points are distributed very evenly about a straight line with a max. variation of $\pm 1{\cdot}7$ per cent, which proves the law of similarity for this tube. When Saph and Schoder's results for galvanised iron pipes are plotted in the same way a different system of curves is obtained; each curve being of different gradient and lying higher as the diam. decreases. For these pipes where the roughness is important the law of similarity needs modification; in the geometrical factors not only l and d occur but also the unevenness (ϵ) of pipe surface. Thus λ is a function of ϵ/d as well as of v/ν. As to the functional form of λ in terms of vd/ν the law of similarity says nothing; experiment is necessary. For $0 < vd/\nu < 2000$ the equation of Poisseuille holds, *i.e.*, $h = 32vl\nu/gd^2$, whence $\lambda = 64\nu/vd$. For $2000 < vd/\nu < 3000$ the transition to turbulence occurs and λ increases from 0·032 to 0·042; for $vd/\nu > 3000$, λ decreases according to another curve which the author finds to be $\lambda = 0{\cdot}3164(\nu/vd)^{\frac{1}{4}}$. A further transition such as Biel asserted does not exist. Biel's discontinuity, which would occur at $v = 12{,}000$, is only the limit of his empirical formula which the author considers ill-chosen. The author remarks that many investigators have proceeded from preconceived notions of the form of λ, which makes the work much more difficult than it really should be. Nusselt's results for compressed air transmission are plotted according to the author's theory, and the value of λ resulting is $0{\cdot}3164(\nu/vd)^{\frac{1}{4}}$, exactly as in the case of water, verifying the conclusions of similarity for two different liquids. The question as to what surfaces are to be considered smooth is discussed. The author's experiments indicate that drawn lead pipe as used by Reynolds, copper pipe as used by v. Lang, and also drawn brass pipe may be regarded as smooth and the value of $\lambda = 0{\cdot}3164(\nu/vd)^{\frac{1}{4}}$ used. Glass tubing may also be considered smooth, though long undulations in the diam. must be noted in measuring v or h. The fact that ν takes account of temperature is verified by experiments on water at 80° C. Immediately after entrance to the pipe the pressure gradient is somewhat steeper than at a point more remote. Thus the author recommends an entrance length of about 50 diams. The results of Darcy may be used for rough tubes, but further experiments are needed to be plotted after the method of the author, using ϵ/d as a parameter. For practical purposes a range of $0 < vd/\nu \leqslant 10^6$ [in cm. units] would be sufficient. This corresponds to a diam. of 0·50 m. and a velocity of 2 m./sec. Skin friction of plates towed in water is discussed, and assuming the formula used by Gebers, $F = \kappa\gamma Av^2/2g$, and plotting κ as a function of vl on the logarithmic diagram, the value $\kappa = 0{\cdot}00890/(vl)^{0{\cdot}186}$ is obtained (vl in m.²/sec.). Introducing ν and assuming the temperature (which was not measured, but guessed) at 10° C., $\kappa = 0{\cdot}0246(\nu/vl)^{0{\cdot}186}$. Prandtl's results for the resistance of wires also satisfy the law of similarity. Four diagrams of plottings are given. H. S. R.

990. *Brownian Movements.* **S. Lifchitz.** (Comptes Rendus, **154.** pp. 1084–1086, April 22, 1912.)—In a previous note [see Abstract No. 777 (1912)] it was shown that the phenomenon of Bjerknes was insufficient to explain the displacement of particles of smoke by a condenser spark discharge. The author now investigates the eddies caused by the spark. Photographs are shown of the case when the "acoustic" oscillations were equal to 6·8 millions per sec. It is seen that certain points (on the axes of the whirlpools) are apparently stationary and that others move appreciably. At lower frequencies the trajectories have greater curvature. At the same time the explosions produce a general displacement of all the particles. The author concludes that a very rapid "sound" shock produces in the gas microscopic eddies, the rotary velocity of which depends on the period of the shock. (Ibid. pp. 1218–1220, May 6, 1912.)—The author here investigates the action of the opening in front of the ultra-microscopic condenser he used in effecting the phenomena. He has found that when the spark takes place the particles of smoke move from the centre of the opening outwards towards the boundaries. When the boundary is a line, all the traces on the photograph are parallel, and perpendicular to this line. A. R.

991. *Mass of Molecules of Liquids, especially of Mercury.* **A. Henry.** (Comptes Rendus, **154.** p. 880, April 1, 1912.)—The calculation is based on the following hypotheses: (i) A liquid is formed of spherical molecules slipping one over the other without friction. (ii) The "energy of passage," absorbed when a molecule passes from the interior to the exterior of a liquid, is measured by the internal heat of vaporisation. (iii) The "energy of approach," absorbed when a molecule passes from the interior of a liquid to the surface, is equal to the superficial energy of that molecule. (iv) The energy of passage is equal to twice the energy of approach. On these assumptions the values of d_0, the diam. and p_0, the mass of a molecule of Hg are found to be $d_0 = 3{\cdot}48 \times 10^{-8}$ cm., $p_0 = 3 \times 10^{-22}$ gm.; and $N_0 = 66{\cdot}6 \times 10^{22}$. For the same quantities the values obtained by Perrin were $3{\cdot}46 \times 10^{-8}$ cm., $2{\cdot}95 \times 10^{-22}$ gm., and $67{\cdot}8 \times 10^{22}$. For other liquids the agreement was not so good, as the following table shows:—

	$d_0 \times 10^8$	
	Henry.	Perrin.
Chloroform	2·2	6·1
Ether	2·1	5·3
Acetone	1·7	4·7
Water	1·0	2·9
CS_2	0·9	4·4

A. W.

992. *New Method of determining the Range of Molecular Action and the Thickness of Liquid Films.* **M. M. Garver.** (Journ. Phys. Chem. **16.** pp. 284–

248, March, 1912.)—It is assumed that the diminution of vapour pressure at a concave surface depends on the range of intermolecular action. Equations are deduced whereby this range may be calculated from the surface tension, liquid and vapour densities, and vapour pressure. The following values for the range, in cm., of intermolecular action are typical :—

Water at 0° C.	$2{\cdot}92 \times 10^{-8}$ cm.	CS_2, at 19·4° C.	$4{\cdot}07 \times 10^{-8}$ cm.
Alcohol at 20° C. ...	$2{\cdot}43 \times 10^{-8}$ cm.	CCl_4 at 20° C.	$5{\cdot}40 \times 10^{-8}$ cm.
Ether at 20° C.	$3{\cdot}65 \times 10^{-8}$ cm.	Benzene at 80° C. ...	$3{\cdot}42 \times 10^{-8}$ cm.

T. M. L.

993. *New Approach to Relativity Theory.* **E. V. Huntington.** (Phil. Mag. 23. pp. 494–513, April, 1912. Reprint from the Heinrich Weber Festschrift, 1912.)—The theory of relativity as developed by Einstein [see Abstract No. 2277 (1905)] is usually supposed to involve a radical modification, not only of our conception of the ether, but also of our fundamental notions concerning space and time; and the discussion of the so-called "paradoxes of relativity" has often led beyond the safe ground of mathematical deduction into the realms of metaphysical speculation. The purpose of the author is to show that the famous "transformation equations" which stand at the centre of the theory can be easily deduced from simple conventions in regard to the *setting of clocks* and the *laying-out of co-ordinate systems,* without any conflict with our ordinary conception of the ether, or with our ordinary notions of space and time, thereby *freeing the theory from the least appearance of paradox.* The method pursued is in some sense a return to the point of view of Lorentz ("Theory of Electrons," Columbia University Lectures, 1906, Leipzig, 1909), who retained the concept of the ether as his starting-point, and never abandoned our ordinary notions of time and space; and the "transformation equations" here obtained resemble those of Lorentz in being slightly more general than Einstein's. But whereas Lorentz's method of deducing these equations involves a large and difficult part of the modern electromagnetic theory, the method here adopted depends only on the most elementary considerations. In its first part, treating a system at rest in the ether, the paper deals first with the regulation and setting of stationary clocks by light-signals, and secondly with the laying out of a system of co-ordinates by the same means. The abscissa x of any station A is $c(t - t_0)$, where c is a constant and t and t_0 are instants of receipt at A and despatch of signal from 0 respectively. Then the velocity of an object passing x_1 at t_1 and x_2 at t_2 as given by the clocks stationed there is expressed by $u = (x_2 - x_1)/(t_2 - t_1)$, and in the general case by $u = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}/(t_2 - t_1)$, whence the velocity of a *light-signal* is equal to the constant c and is the same in all directions. The observed rate of a moving clock is obtained as follows: Suppose the clock at A to give the reading t_1, when the moving clock passes it, t_2 being the reading of the clock at B when the moving clock passes it, T′ being the number of seconds ticked off by the clock when moving from A to B. Then the ratio (if it proves constant) $r = T'/(t_2 - t_1)$ is called the *observed rate* at which the moving clock is running with respect to the fixed clocks; that is, the moving clock is said to be running r times as fast as the fixed clocks. Further, the quantity, $n = AB/T'$, may be called the *self-measured velocity* of the moving clock with respect to the fixed ones. The relation of the two quantities u, the observed velocity of the moving clock and n, its self-measured velocity, is $u/n = r$. In all so far the fixed clocks are supposed

at rest in the ether. The second part of the paper treats of a system in uniform motion through the ether. In the early portion of this the following fundamental theorem is established. THEOREM.—*If the co-ordinates x', y', and the clock-reading t' at each station on the moving platform S′ are assigned, at each instant, in terms of the co-ordinates x, y, and the clock-reading t at the point on S which is opposite that station at that instant, according to the following "transformation equations":—*

$$x' = lk(x - vt),\ y' = ly,\ t' = lk(t - vx/c^2),$$

where—

$$k = 1/\sqrt{1-(v/c)^2} \text{ and } l = r/\sqrt{1-(v/c)^2},$$

then the result will be precisely the same as if the observers on S′ had adjusted their clocks and laid out their co-ordinate system by the method of light-signals explained above for the fixed platform S, with the same choice of the constant c. Here v is the observed velocity of the moving origin O′ with respect to the platform S, and r the observed rate of the clock at O′. In the third part, on the principle of relativity, it is shown that: *Observers in a system moving with uniform velocity through the ether can never detect that motion by any observations which they can make.* Other theorems and assumptions are given, and the paper closes with an appendix containing an elementary method of proof for the theorem given above. E. H. B.

994. *Isostasy and Variations in Gravity.* **F. R. Helmert.** (Preuss. Akad. Wiss. Berlin, Ber. 20. pp. 308–332, 1912.)—After reviewing the arguments which led up to the advancement of the theory of isostasy, the author discusses in considerable detail the chief oceanic gravitational surveys. The variations found in the force of gravity over the Pacific, Atlantic, and Indian Oceans are compared with the variations found over continental and littoral areas, and the results are discussed in their bearing on the Pratt-Hayford hypothesis. A. D. R.

995. *Summer Rains in North Germany.* **G. Hellmann.** (Preuss. Akad. Wiss. Berlin, Ber. 18. pp. 282–308, 1912.)—These results are derived from ten years' autographic records of rainfall obtained from eight stations in the north plain of Germany; from two mountain stations, Schneekoppe and Brocken, for a shorter period, and from Potsdam for a longer period. The instruments in use at all the stations are of the author's own design, in which the time scale of the records is sufficiently open to allow of a two minutes' duration of rain to be accurately identified. The summer months, May to Sept., were selected in order to avoid the difficulty of dealing with snowfall. The number of showers in a rain-day is first considered, and a table is given of the numbers of occasions on which one, two . . . showers were recorded, expressed as percentages of the total number of rain-days. The greatest number of showers in a day is 18, and that number was recorded only at two stations. The percentage number of days of rain on which only one shower fell is 32, for two showers it is 22, for three 16, for four 11; and the numbers continue to decrease approximately in geometrical progression. Rain-days with one shower are usually days of thunderstorm, or of the heavy type of rain without thunder known in Germany as "Platzregen." Days with frequent showers are generally associated with definite barometric depressions. The investigation of the duration of showers is next dealt with. Showers are classified under different headings according as they last from 1 to 15 min., 16 to

30 min., 31 to 45 min., 46 to 60 min., 1 to 2 hrs., 2 to 3 hrs., &c., and the number in each class is expressed as a percentage of the total number of showers. The class of showers lasting less than 15 min. has far more entries than any other, the percentage frequency for this class being 31, and after allowing for the greater step of time (1 hour) taken to separate showers of the longer durations, the percentages fall off rapidly as the duration of the shower increases. There is a table of exceptionally long continuous showers, the longest being one of 48 hours on Sept. 14–16, 1901, when 33 mm. of rain fell. Tables follow giving the mean duration of rain on a rain-day and the percentage frequency of rain in each hour of the day. With regard to the latter, two types of rain are distinguished—the continental and the oceanic—in which the rain falls most frequently in the afternoon hours and in the night hours respectively. At the German stations the type is usually a combination of both of these, that is, the curve shows two maxima, one in the afternoon and one at night; and the type is termed continental-oceanic (inland stations) or oceanic-continental (coast stations) according as the afternoon or night maximum predominates. Next follow tables giving the mean duration of rain in each hour of a rain-day and the mean amount of rain falling in each of the "rain-hours." The author classifies summer rains into two main divisions, according as the rain is derived from water at a distance or is formed locally by convection. To the former class belong rains due to barometric depressions; to the latter belong local showers, often of great intensity (Platzregen), and local thunderstorms frequently accompanied by hail. The former class produces the long-continued and widely-distributed rains, but it is also responsible for some rains of short duration associated with the rear of a receding depression. R. C.

996. *Further Remarks on Wind Squalls* (*Böen*). **W. Schmidt.** (Meteorolog. Zeitschr. 29. pp. 103–110, March, 1912.)—The author points out that the apparent vortex with horizontal axis in the head of his advancing column [see Abstracts Nos. 276 and 480 (1912)] is not of any importance for the squall. The apparent stream-lines merely represent the instantaneous velocity-distributions in a plane at right angles to the direction of the propagation; the vortex might be called forced by analogy to forced vibrations. The falling hail and rain may carry some air with them and throw it forward; but this will not cause any wind, except with the very heaviest downpours. The calculation of the velocity of propagation confirms the author's views. H. B.

997. *The Temperature at Mount Weather and Adjacent Valley Stations.* **A. J. Henry.** (Mount Weather Observatory, Bull. 4. 5. pp. 310–341, 1912.)—The principal part of this paper is devoted to a discussion of the temperature-differences between Mount Weather Observatory, which is situated on the summit of the Blue Ridge Mountains, 1725 ft. above the sea, and three low-lying stations in the vicinity. The range of mountains runs in a NE.–SW. direction, and of the three stations one, Audley, lies at the bottom of the valley to the NW., 7½ miles distant; the second, Benton's, at the bottom of the valley on the other side of the ridge, 8 miles distant; and the third, Trapp, at the foot of the mountain to the SE. but only 1½ miles from the observatory. The height of the latter above Trapp is 1013 ft., above Benton's 1275 ft., and above Audley 1226 ft. It is pointed out that the average temperature-difference between mountain and low-level stations is about ½° C. per 100 m. or 1° F. per 365 ft. of altitude. Taking this as a basis the monthly mean tem-

perature at Mount Weather differs from that at Trapp by somewhat more than was to be expected, and from that at the two valley stations by slightly less. The latter is accounted for by the frequent occurrence of negative gradients between Mount Weather and the valley stations, which are brought about by the settling down of cold air to the bottom of the valleys. This air flows past Trapp but settles around the valley stations. This effect was strongly marked during an anticyclone which remained stationary over Mount Weather from Oct. 5–10, 1909. The temperatures during this period are discussed in detail. It is pointed out that this effect can only take place when there is an absence of wind; and it does not hold for Mount Weather that in general the lowlands in winter are cooler than the adjacent mountain summits, as is said to be the case elsewhere. The figures for temperature gradient are separated into two groups according to whether the sky is clear or cloudy, and various points brought out by this grouping are enumerated. The temperature gradients with different wind-velocities are also discussed. The remainder of the paper deals with rapid temperature-changes in the free air revealed by kite observations. One of the most remarkable of these was found on Jan. 4, 1910, when a rise of nearly 6° C. at the 1000-m. level occurred in the 2½ hours between the times of ascent and descent of the kite. Various hypotheses as to the cause of this rise are reviewed, but all are rejected as unsatisfactory and the phenomenon is left unexplained. Charts are given showing the pressure distributions associated with several of these rapid changes. J. S. Di

998. *Representation of Temperature as a Function of Cloudiness.* **H. Perrotin.** (Comptes Rendus, 154. pp. 1014–1016, April 15, 1912.)—The author has undertaken an analysis of the distribution of mean temperature of the air over the globe, with a view to determining to what extent the variations from place to place depend upon conduction and on absorption and radiation respectively. In the first place the month of July was selected for the Northern Hemisphere as one in which general atmospheric motion is comparatively small, and for which the influence of conduction may therefore be neglected in comparison with that of radiation and absorption. Since absorption is affected very considerably by the amount of cloud, an attempt was made to find for each selected station a relation between temperature and cloudiness, and it appears that an equation of the form $t = t_0 + ac$, where t is temperature, c is cloudiness, a is the "coefficient of cloudiness," and t_0 is an ideal temperature, is approximately satisfied by the observations from 24 stations in the Northern Hemisphere for July, at latitudes varying from 29½° N. (New Orleans) to 70° N. (Vardö). The coefficient a is negative and its value is about $-1{\cdot}0$ when temperature is expressed in Centigrade degrees and cloudiness is expressed on the 0–10 scale. t_0 is thus the ideal air temperature which is expected to prevail if no clouds are present; its value for Paris is 26° C., for Milan 29° C., for New Orleans 31° C., and for Vardö 16·5° C. Moreover, for stations in the same latitude the values for t_0 are nearly the same. It is proposed to extend the inquiry to the Southern Hemisphere for the month of Jan., and afterwards to take into account the absorption of the atmosphere so as to bring the results into relation with the value of the solar constant. R. C.

999. *Free Air Data. Sounding Balloon Ascensions at Indianapolis, Omaha, and Huron.* **W. R. Blair.** (Mount Weather Observatory, Bull. 4. 4. pp. 188–304, 1912.)—The paper contains the results of four series of sounding balloon ascents which were carried out by the Mount Weather Observatory

during the years 1909–11. In the first series balloons were sent up simultaneously from Fort Omaha, Nebr., and Indianapolis, Ind. In the remaining series the ascents were from one station only. Seventy-nine successful records were obtained. The rate of ascent of the balloons was deduced from the meteorograph record, and the means over each km. of height from 0–18 km. show a gradual increase in the rate from 3 m./sec. near the ground to 5 m./sec. at 15 km. height, with a decrease above this level. This variation in rate is explained by the author as being probably due to a lag in the temperature of the gas behind that of the surrounding air, which thus causes an increase of buoyancy where the temperature of the air is falling rapidly. In order to get an adequate amount of data, that obtained by the Blue Hill Meteorological Observatory is included with the Mount Weather observations for purposes of general discussion. The temperature data are grouped with reference to rising and falling air pressure at the earth's surface, and it is found that in general in the lower layers of air (to about 10 km.), lower temperatures exist over rising than over falling pressure, with a reversal of this distribution at higher levels. The lower surface of the strato-sphere is termed by the author the surface "S." Whereas this is found at a mean height of about 10 km., the coldest mean temperature occurs at 15–16 km. This surface of minimum temperature is considered to be a region of some importance. After discussing humidity observations, wind direction and velocity are dealt with. The tracks of the individual balloons are plotted. Twelve were followed till they passed through the surface S, at which no characteristic change of wind was found. At the surface of minimum temperature, however, there was usually a marked drop of wind velocity. The change in wind direction with height was generally such as to bring the wind at these upper levels into the west quarter. The height and temperature of the surface S, and that of minimum temperature are discussed in detail, and it is pointed out that the conditions revealed do not altogether bear out the assumptions made in some recent theoretical papers on the subject. In dealing with convection the author states that condensation due to vertical convection currents takes place in two fairly well-defined layers. The limits of these layers are shown in the vertical temperature gradient. The lower layer extends from about 1·2 km. to about 5 km. and the upper from about 9 km. to the surface of minimum temperature. Discussions are also given on "Nucleation" and "Absorption and Radiation." The numerical results of the ascents are set-out in a very complete set of tables and diagrams, the latter including charts showing the movements of depressions and anticyclones during the periods of the different series of ascents. J. S. Di.

1000. *Vertical Temperature Gradients in Hawaii.* **A. J. Henry.** (Mount Weather Observatory, Bull. 4. pp. 305–306, 1912.)—The paper gives the vertical temperature gradient deduced from observations at two high-level and two corresponding low-level stations. The difference in height above the sea is 2007 m. for one pair of stations and 1186 m. for the other. The gradient lies between 0·5 and 0·6° C. per 100 m. of height. Practically no annual range is shown. The value of the gradient differs only slightly from that already found for mountain regions in the Tropics. J. S. Di.

1001. *Microseisms and Atmospheric Pressure.* **J. E. Burbank.** (Amer. Journ. Sci. 33. pp. 470–473, May, 1912.)—Observations made since 1906 at Cheltenham show that the most pronounced microseisms were connected with the passage of deep atmospheric depressions across the coast-line. These earth tremors are not produced to an appreciable extent by the movement of cyclonic depressions over the land, and anticyclonic systems have generally too slight a gradient to produce measurable effects. The period of the microseism is from 8·0 to 8·5 sec., regardless of the part of the coast under strain and of the geological nature of the rock strata concerned. Periods greater than 8·6 sec. apparently occur only when the depression is of great extent and the centre almost wholly over the ocean. It would appear from this that the period of the microseism varies with the extent of the disturbed water area, but there is no apparent connection between the microseism and movement of water masses produced by the wind accompanying the pressure changes. A. D. R.

1002. *Microseisms and Frost Action.* **J. E. Burbank.** (Amer. Journ. Sci. 33. pp. 474–475, May, 1912.)—An examination of seismograms for a period of several years past shows that whenever actual freezing or thawing of the ground is taking place at Cheltenham microseisms are recorded as irregular movements of the seismograph boom. The most common period is 8 to 14 sec., but they frequently have a period as great as 2 min. The amplitude increases with the intensity of the freezing or thawing, the usual range of motion of the earth particles being 0·02 to 0·10 mm. These microseisms are continuous as long as the ground is frozen, and continue without appreciable diminution when the frozen ground is covered with snow. In this last case the microseisms are probably due to the thawing-out of the lower layers of frozen ground in contact with the warmer layers below. A. D. R.

1003. *Earthquake of* 1912, *January* 24. **D. Eginitis.** (Comptes Rendus, 154. pp. 1264–1266, May 6, 1912.)—Particulars are given of the effects of the Ionian earthquake and of the seismograms obtained at Athens, Rome, Vienna, Jugenheim and Hamburg. From the available data the epicentre is located near the south-east coast of the island of Cephalonia. A feature of the earthquake is the number and violence of the after-shocks which have continued for some months. A. D. R.

1004. *Seismic Waves and the Earth's Interior.* **K. Zoeppritz, L. Geiger and B. Gutenberg.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 2. pp. 121–206, 1912.)—The paper is in two parts. The first, which is by the late K. Zoeppritz, has been edited by Wiechert, and deals with the amplitude of the first preliminary tremors and the relation between the distance of the seismic centre, the time of propagation of the disturbance, and the angle made by the path with the normal to the earth's surface. In the second part of the paper the observations of the time of propagation of the longitudinal waves have been combined with Geiger's observations of the relations existing between the ground displacements in direct and in once-reflected longitudinal waves. Using the whole of the Göttingen data for the period 1904–11, it has been found possible to improve on the Weichert-Zoeppritz propagation-time function. Whilst Wiechert and Zoeppritz assumed only one surface of discontinuity of the elastic properties of the material of the earth's interior, viz., at a depth of 1519 km., the present authors have been led to consider the existence of three such surfaces. These they place at depths of 1194 ± 50, 1677 ± 100, and 2436 ± 150 km. While there is, therefore, considerable uncertainty as regards the exact position of these surfaces of discontinuity, there is little uncertainty in the epicentral distance for the corresponding tangential paths. These distances are 40·8° ± 1°, 68° ± 2°, 76° ± 0·5°. This change in the assumed condition of the earth's interior alters the propagation-times of longitudinal waves corresponding to distances of the seismic origin exceeding 40 degrees, but the alteration is not great. The greatest velocity of such waves in the earth's interior now comes out at 13·3 km. per sec. instead of at 12·8 km. per sec. A. D. R.

1005. *Age of the Earth.* **S. Suzuki.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 14. pp. 204–207, March, 1912.)—In the present note an attempt is made to estimate the time that has elapsed since the molten surface of the earth began to solidify. The assumption is made that at first a thin crust of solidified rocks was formed, which grew in thickness at such a rate that the heat of fusion liberated at the boundary of the solid and liquid portions supplies the loss of heat from the surface. For the present thickness of the crust two values are taken, viz., 50 and 60 km., according to the views of Arrhenius, Milne, and others. The results obtained for three rocks are as follows :—

Rocks.	Densities.	Conductivities.	Specific Heats.	Melting-points.	Heats of Fusion.	Age of Earth in Millions of Years for	
						Crust 50 km.	Crust 60 km.
Gneiss ...	2·6	0·000578	0·1726 0·2143	1300	103	210	300
Basalt ...	2·7	0·00320	0·233	1010	100	43	61
Granite...	2·6	0·00500	0·190	1240	88·6	23	30

The heats evolved by the shrinkage of the earth and by radio-active minerals are not here brought into account. E. H. B.

1006. *Influence of the Earth's Rotation on Pure Drift-currents.* **D. F. Tollenaar.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 1149–1158, May 23, 1912.)—The object of the paper is to obtain a mathematical determination of the current produced at any depth by the action of wind on the surface of water, taking into account the acceleration normal to the path due to the earth's rotation. The water is supposed to start from a condition of rest at time $t = 0$ in all cases. The case of a constant wind and sea of infinite depth is first considered, and a general expression for the current velocity after time t worked out in these conditions. This result is compared with an earlier solution of the same problem given by Fredholm, and it is pointed out that the latter was based on erroneous initial equations, and is therefore not strictly correct. Comparison with the author's results, however, shows that the difference between the two solutions may be neglected for practical purposes for about the first 11 hours from the commencement of motion. Thus Fredholm's formula is practically serviceable for studying the development of a current. It is also mathematically correct after such time that the conditions have become steady. Since thus for a sea of infinite depth the theoretical correction to Fredholm's formula may be practically neglected and as the faulty equations on which it is based lead to much simpler results than the mathematically correct solution, the author of the present paper feels justified in adopting the same faulty equations for dealing with a sea of finite depth. Under these conditions the general equations are worked out. It is found that the surface current at time t for a sea of finite depth h is equal to the surface current at the same time t in a sea of infinite depth, diminished by twice the current which in that case would exist at depth $2h$, increased by twice the current at depth $4h$, &c. J. S. Di.

1007. *Measurements of Temperature of the Lava flowing from Etna.* **G. Platania.** (Accad. Lincei, Atti, 21. pp. 499–502, April 14, 1912.)—The determination of the temperature of flowing lava is a most important element in the physical study of volcanoes. But direct measures have hitherto been very few; some have been made by Bartoli in 1891 and Oddone in 1910 on the occasion of eruptions. Visits were made, first to the more elevated peaks, and later to the long series of small craters as far as Monte Rosso. The apparatus (Féry radiation pyrometer) was set up, and readings were made by the help of F. Platania, G. T. Castorina, and Mauro. The first series of readings gave comparatively low temperatures, 560°, 640°, 660°, 680°, and 770°, which might be considered as temperatures of the surface lava and the scoriæ. A huge block, which had a slow motion of rotation, gave 940° as its temperature. The observations of Bartoli by a calorimetric method in 1892 (July–Dec.), sometimes made within 2 m. from a current of lava, gave temperatures from 870° to 1060°. Oddone's observations in 1910 were not very satisfactory, but for white lava the superficial temperature seemed to be about 1200°; golden yellow, about 1150°; for lava of a ruddy orange, 1050°; and for auroral (?) red, < 1000°. It is not advisable to contrast the various results obtained, for more systematic observations are necessary. The author's results obtained from observations with the lava emitted towards the end of an eruption are not without importance; they show, amongst other things, the utility of the radiation pyrometer (Féry) for this purpose, and under favourable conditions it may be possible to obtain comparison of temperatures of the different tinted lavas, in the central and outer parts of the stream, and at different depths. F. W. H.

1008. *Observations of Nova Geminorum 2, made at the Observatory of Catania.* **A. Ricco.** (Accad. Lincei, Atti, 21. pp. 533–534, April 21, 1912.)—Observations have been made from March 20 to date, the observers principally employed being V. Fontana and A. Bemporad. The colour of the Nova was generally of an orange-yellow tint, changing latterly towards red. Its luminosity was in general decreasing; magnitude on March 20, 5·5; on the 25th there was a rise to mag. 4·9; on the 27th a minimum 6·4; now (April 10) the magnitude is about 6. The spectrum has been usually that characteristic of Novæ: a continuous spectrum from red to violet, more luminous towards the red end, as was the colour of the star; the hydrogen lines were broad and bright on the less refrangible side, darker on the other side; there were also present bright lines of He, Ca, Mg, &c., and the bright line $\lambda = 501\,\mu\mu$ characteristic of [many] nebulæ, attributed by some to a new element *nebulium*, according to others due to nitrogen. The spectroscopic observations showed the presence of the Fraunhofer lines C, F, G, *b*. Comparison with the flash spectrum obtained during the 1905 eclipse of the sun showed all the bright lines there present. A table is given of 16 lines measured and identified with the above-named elements. Variations in the spectrum were noticed in the course of the observations, but will be dealt with in a future paper. F. W. H.

1009. *Apparatus for Rapid Distillation of Mercury in Vacuo.* **L. Dunoyer.** (Comptes Rendus, 154. pp. 1844–1846, May 30, 1912.)

1010. *Icebergs and their Location in Navigation.* **H. T. Barnes.** (Engineering, 93. pp. 774–775, June 7, 1912. Discourse delivered before the Royal Inst., May 31, 1912. Nature, 89. pp. 411–414, June 20, 1912. Abstract.) —Deals with the application of the author's microthermometer [see Abstract No. 1000 (1911)].

1011. *Molecular Physics.* **J. J. Thomson.** (Engineering, 93. pp. 293–294, March 1; 324–325, March 8; 355–356, March 15; 425, March 29; and p. 461, April 5, 1912. Abstract of Lectures delivered at the Royal Inst.)—Illustrated with descriptions of experiments.

1012. *Movements of the Surface of a Liquid under an Attractive Force directed to a Centre.* **G. Bouligand.** (Comptes Rendus, 154. pp. 1338–1340, May 20, 1912.)—A mathematical equation which represents the motion of the fluid in this case is obtained when the displacements of the particles of the fluid at the surface are very small. A. R.

1013. *Hydrodynamics of the Relativity Principle.* **E. Lamla.** (Ann. d. Physik, 37. 4. pp. 772–796, March 26, 1912.)—A mathematical paper showing that Hamilton's principle and that of relativity suffice to provide a dynamics of perfect fluids. [See Abstract No. 29 (1912).] E. H. B.

1014. *Geoid Differences after Stokes' Formula. Gravity Determinations* **R. Schumann.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1655–1707, Dec., 1911.)—The paper is unsuitable for a brief abstract, and should be consulted in the original. L. H. W

1015. *The Wave-problem of Cauchy and Poisson for Finite Depth and slightly Compressible Fluid.* **F. B. Pidduck.** (Roy. Soc., Proc. Ser. A. 86. pp. 396–405, April 25, 1912.)—A mathematical treatment.

1016. *Matter and Ether.* **H. Poincaré.** (Journ. de Physique, 2. Ser. 5. pp. 347–360, May, 1912.)—A *résumé* of modern views of the relations of matter and the ether. E. H. B.

1017. *Notes on the Viscosity of Liquids.* **A. W. Porter.** (Phil. Mag. 23. pp. 458–462, April, 1912.)

LIGHT.

1018. *Deposition of Metallic Mirrors by Distillation in Vacuo.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 14. 9. pp. 506–507, May 15, 1912.)—For research on the selective photoelectric effect it was necessary to secure metal surfaces which were free from oxide and other surface impurities. For this purpose metals were distilled *in vacuo*, and in this way mirrors of very high optical reflecting power were obtained with metals not hitherto obtained in mirror form. The metals were vaporised in an electric oven of very small dimensions, and deposited themselves on a glass or quartz plate close to one of the oven openings. The whole apparatus was enclosed, and, after prolonged heating, was evacuated, the pressure during distillation being about 0·001 mm. of Hg. Metallic mirrors of Ag, Ce, In, Al, and Ca were obtained. For details of the apparatus, see original paper. A. W.

1019. *Optical Effects in Moving Media.* **Y. Laub.** (Phys. Rev. 34. pp. 268–274, April, 1912.)—Abraham in 1908 proposed a modification of Einstein's electrodynamical theory. He abandoned the principle of a constant velocity c of light and substituted $c' = c\sqrt{(1 - v^2/c^2)}$, where c' is the velocity measured by an observer moving with velocity v. Conversely the time of a watch is independent of the movement of the reference system. The electromagnetic equations accordingly retain their invariant character, since only the product ct comes into account, and $c't' = ct\sqrt{(1 - v^2/c^2)}$ still holds. Some possibilities of experimentally distinguishing between the two views are discussed. [See Abstract No. 1062 (1909).] E. H. B.

1020. *Speed of Light in Refracting Media.* **C. Gutton.** (Journ. de Physique, 2. Ser. 5. pp. 196–208, March, 1912.)—In a previous paper the author has described his comparison of the speeds of light and of electric waves along wires, using carbon disulphide. By an analogous method he has now measured the ratio of the speeds of light in air and in a refracting liquid. The arrangements and results are given in a diagram and tables. [See Abstracts Nos. 781 and 861 (1911).] E. H. B.

1021. *Selective Transmission and Dispersion of the Liquid Chlorides.* **H. H. Marvin.** (Phys. Rev. 34. pp. 161–186, March, 1912.)—The transmissivity of each of ten liquid chlorides in the region $1{\cdot}5\,\mu$ to $16\,\mu$ was observed, and the refractive indices of eight were determined for a wide range of wave-lengths. The Maclaurin and the Sellmeier dispersion formulæ represent equally well the observed values of the indices. The value of the constant K in the Maclaurin formula—

$$\frac{n^2 - 1}{n^2 + a} = \frac{K - 1}{K + a} + \frac{c_1}{\lambda^2 - \lambda_1^2} + \frac{c_2}{\lambda^2 - \lambda_2^2} + \cdots,$$

is in good agreement with the observed value of the dielectric constant in each case, while the value of K in the Sellmeier formula differs by an amount which increases with the dielectric constant. The Maclaurin formula is therefore in better accord with the results of experiment than the Sellmeier. The most satisfactory value of the constant a in the Maclaurin formula for liquids is 2. The wave-length of the strong infra-red absorption band increases with the combining weight of the base, for the series of tetrachlorides. This relation appears not to hold for bases of different valence. The wave-length for which the dispersion is minimum is approximately proportional to the combining weight of the base, whatever the valence of the base. A. E.

1022. *Magnetic Birefraction and Chemical Constitution.* **A. Cotton** and **H. Mouton.** (Comptes Rendus, 154. pp. 818–821, March 25, 1912.)—About a hundred chemical compounds have been investigated for the purpose of the research. The measures, however, are not given, but only the general results. For each substance, the ratio b of its doubly refracting power to that of nitrobenzene, taken as standard, was measured, and then divided by the density. The quotient b, is called the specific magnetic birefraction of the liquid concerned. The important rôle played by a benzene nucleus is clear. All liquids of which the molecule contains such nuclei have a positive magnetic birefraction easily measurable. If the nuclei are altered by suppressing the double linkages, the magnetic double refraction always diminishes. If, instead of the nucleus being modified, one or several of the hydrogens attached to it be replaced by monovalent atoms or groups, then the birefraction may increase or diminish, but remains of the same order of magnitude. In studying the monosubstituents of napthalene, it is found that the groups play the same part, and have the same order of activity, and that each substance is more birefringent than in the case of the corresponding benzene derivative. This rule appears to extend to some substances studied which contain complex or heterocyclic nuclei. The influence of the same atoms or groups can still be recognised when several identical ones are introduced into the same nucleus, but the place of substitution has import, for the isomers of position give different results. For example, *m*-xylene is rather less active than the other two xylenes, mesitylene decidedly less active than pseudocumene. Further, in the more complicated case where several different groupings are substituted simultaneously, the more active, such as NO_2, seem to play the same rôle as in the simpler compounds. The authors remark that the part played by the groups can easily be explained on the hypothesis of molecular orientation which has served to guide their researches, and that it has led to their discovery of a faint magnetic birefraction in certain non-aromatic substances. A. E.

1023. *Interference Fringes obtained with Fresnel's Triprism.* **G. Meslin.** (Comptes Rendus, 154. pp. 764–767, March 18, 1912.)—A slit combined with a split lens, or a converging biprism, is used to give two images P and P′. On placing the triprism beyond P and P′, various systems of fringes may be seen superposed in the field of view. In natural light, or in light which is polarised but not analysed, two lateral groups appear, the position of which is independent of transversal displacement of the triprism. In polarised and analysed light two other systems, likewise lateral and symmetrical, are also seen, but these move in opposite directions when the triprism is displaced transversally. Two groups of broad fringes appear as well, superposed on the preceding, but in their case when the prism is shifted both groups move in the same direction. The author offers a mathematical explanation of the phenomena. A. E.

1024. *New Methods of Speed and Gamma Testing.* **A. Watkins.** (Photographic Journ. 52. pp. 206–217; Discussion, pp. 217–221, May, 1912.)—On the curves of the Hurter and Driffield system representing increasing exposures on a normal plate, there appear to be three definite points from which the speed of the plate may be ascertained. These points are: (1)The lowest visible image, (2) the lower end of the straight line of correct exposure, and (3) the upper end of the straight line of correct exposure. From these it would appear that a fourth point, the centre of the straight line of correct exposure, could be ascertained. But Hurter and Driffield did not adopt either of these: the point they adopted is not on the curve at all, but is the theoretical inertia, or smallest exposure having a visible effect, if the plate were all in a straight line of correct exposure. They selected this point for convenience of observation, but observed that the best point of all to adopt would be that of double flexure, which is now interpreted as the centre of the straight line of correct exposure. The "central speed" method is explained and a simple instrumental arrangement is described by means of which it is possible to observe the central speed and the gamma, and to ascertain the density of any desired exposure. The gamma results are read off direct from a scale; the only calculation required is to divide the observed gamma by 2. The instrument also provides an accurate means of observing the exposure which gives the lowest visible image. The methods of gamma testing, calculating gamma from density, and calculating inertia from gamma and density are described. A. E. G.

1025. *Polarisation of Light by Internal Diffusion.* **G. Dimmer.** (Akad. Wiss. Wien, Ber. 119. 2a. pp. 1073–1089, July, 1910; 120. 2a. pp. 283–302, March, 1911; and pp. 937–965, June, 1911.)—The author finds that, while internal diffusion tends to depolarise the light, absorption simultaneously tends to polarise it more highly. The product of degree of polarisation by transparency increases with the transparency, being greatest for the clearest substances. This result agrees with what was found by Chmyrow and Slatowratsky for the case of external diffusion. The author also investigates the dependence of polarisation upon the inclination and intensity of the scattered light, and the situation of the plane of polarisation. A. E.

1026. *Absorption Spectra of some Metallic Solutions.* **W. N. Hartley.** (Chem. Soc., Journ. 101. pp. 820–826, May, 1912.)—Schaefer has shown that the absorption spectrum of 0·37 mm. of solid potassium nitrate is almost identical with that of 75 mm. of N/10 solution; the property is therefore that of the salt and not of its hydrates. He attributes the variations in the spectra of the nitrates of certain metals to the specific absorptive properties of the metals. By examining a variety of metallic salts it is now shown that no metal of the group, Tl, Ag, and Pb, by its specific absorption, obscures or interferes with the absorption spectrum of its nitrate, notwithstanding that each of them, like the metal Th, shows a distinctive general absorption. T. M. L.

1027. *Absorption of Light in Solid and Gaseous Substances.* **J. Koenigsberger** and **K. Küpferer.** (Ann. d. Physik, 37. 4. pp. 601–641, March 26, 1912.)—A series of dye-stuffs was examined which showed simple characteristic absorption-bands. The e/m ratio of these oscillations corresponds in every case with one electron per one or two molecules. With rising temperature the "damping" increases; the bands become broader, and are displaced towards the red. The vapours of the dye-stuffs give nearly the same e/m ratio and nearly the same damping; *the damping is therefore intramolecular,* since otherwise it would be 10,000 times smaller. The damping corresponds with the kinetic energy which the separate parts of the molecule acquire, and is approximately proportional to $\sqrt{T}$. The vapours of compounds and elements (metals and insulators) show, if they are not dissociating, only continuous absorption in the visible spectrum; this is taken to indicate that gases and vapours normally produce continuous absorption and emission, and that banded absorption and emission spectra are caused by a momentary condition depending on the resolution of the molecule into two electrically-neutral components. Dye-stuffs which fluoresce in solution show no fluorescence when their vapours are illuminated with visible light.

T. M. L.

1028. *Relative Velocities of the Luminous Vapours of different Elements in the Electric Spark.* **G. A. Hemsalech.** (Comptes Rendus, 154. pp. 872–874, April 1, 1912.)—Continuing his research on the movements of the metallic vapours in the self-induction spark, the author has studied, by his air-blast method [see Abstract No. 849 (1912)], the trajectories of the vapours of fourteen different elements. The spark-length was always 5 mm., the self-induction 0·0125 henry, and the capacity that of 6 plate condensers, except in the case of Ca and Al, when, on account of the great quantity of vapour produced, only two and one condenser respectively were required. The air current used varied between 15·3 and 43·9 m. per sec. according to requirements. A table is given of the results, which are discussed. A. W.

1029. *Structure of the Telluric Bands due to Oxygen.* **R. Fortrat.** (Comptes Rendus, 154. pp. 869–872, April 1, 1912.)—The three telluric bands A, B, and α have been dealt with by many experimenters. Higgs considered the two parts of each band as formed of nearly equal doublets. He concluded, as also did Lester, that each band is formed of four distinct series of lines. The author here shows that the two parts (the less and more refrangible parts) can be connected with one another by a single formula, whose principal part is of the form $N = am^2 + bm + c$, where $m = 0, \pm 1, \pm 2, \pm 3 \ldots$ Each band is thus composed of two equal series nearly obeying Deslandres' law. The better known is the band B; for this $N = -25{\cdot}7\,m^2 - 14{\cdot}8\,m + 1456120 - 0{\cdot}0122\,m^3$. The two lines corresponding to $m = \pm 11$ are wanting. For the band A the formula deduced from Cornu's numbers is $N = -20{\cdot}4\,m^2 - 15\,m + 1316670 + 0{\cdot}0005\,m^4$, which lacks the lines $m = \pm 14$. The corresponding formula for the band α is $N = -30{\cdot}51\,m^2 - 19\,m + 1593190 - 0{\cdot}0026\,m^4 - 0{\cdot}02\,m^3$, which lacks the lines $m = \pm 9$.

A. W.

1030. *Band Spectrum of Strontium Fluoride in the Electric Arc.* **P. Leopold.** (Zeitschr. wiss. Phot. 11. pp. 105–118, and pp. 137–149, May, 1912.)—Well-defined bands were successfully photographed in the arc spectrum of SrF_2, a Rowland grating (16,000 lines to the inch and 6·59 m. radius) being used. Carbon poles were used, the positive having a hole 2–3 mm. diam. bored in it and filled with as pure as possible SrF_2. Photographs of the bands are given, with tables of the wave-lengths, which are compared with the results of Rösch and of Fabry [see Abstract No. 983 (1905)]. The numbers obtained are used to test the validity of Deslandres' third law, that the heads of a group of bands should satisfy the relation

$1/\lambda = N = A \pm Bn^2$. It appears that this form of Deslandres' law does not agree with the SrF_2 groups. Good agreement is obtained between calculated and observed results when the Fabry formula $N = A \pm B^2(m + C/B)^2$ is used. A. W.

1031. *Fluorescence of Sodium Vapour.* **L. Dunoyer.** (Comptes Rendus, 154. pp. 815–818, March 25, 1912.)—Fluorescence of sodium vapour is generally described as green. The author's experiments show that the character of the fluorescence excited by white light is influenced considerably by the degree of purity of the sodium, and that the green tint is due to emitted gases. The sodium is distilled into a glass bulb in which a very high vacuum, 0·0001 mm. of mercury, has been produced, and the bulb is then heated uniformly and an arc light is concentrated upon it. At a temperature of about 210–220° a faint yellow fluorescence appears, and grows brighter as the temperature rises. Spectroscopic examination shows that it consists wholly of light from the D line. But at about 290° the fluorescence begins to turn green. At the same time the grey crust of oxide on the metal is cracked by the bursting-out of gases occluded in the sodium. A McLeod gauge indicates abundant liberation of gas. Besides the occluded gas, hydrogen is liberated by the metal attacking the oxide. If the temperature is raised, say, to 330°, while the mercury pump is kept going, the green tint becomes more intense and accentuated. Sometimes, as found by R. W. Wood, the channelled green spectrum appears unaccompanied by the D line, but this only occurs under certain conditions of balance of pressure. When the temperature is lowered again, the green fluorescence disappears at 290°, while the yellow fluorescence persists to a considerably lower temperature. Dunoyer suggests that the series of equidistant lines seen by Wood with certain monochromatic exciting sources may be explained by supposing the lines to correspond to combinations of one atom or molecule of sodium with 0, 1, 2, 3, ... or *n*, atoms respectively of a foreign gas. By separating the arc carbons sufficiently, it is possible to obtain in the vapour two fluorescent pencils, corresponding, one to the positive crater, the other to the negative carbon. When the sodium vapour is pure, both these pencils are yellow; when the proportion of emitted gas is large enough, both are green; an intermediate case arises where the pencil corresponding to the crater is green, and to the negative carbon yellow. The action of the occluded gases upon the tint of the fluorescence is compared to the action of helium on iodine fluorescence noted by Wood. A. E.

1032. *Fluorescence of Minerals of the Sodalith and Willemite Groups in Ultra-violet Light.* **T. Liebisch.** (Preuss. Akad. Wiss. Berlin, Ber. 13. pp. 229–240, 1912.)—Different specimens of one mineral varied greatly in behaviour; as a rule, those of dark colour responded feebly. Tables are given showing the exciting effect of various lines in the spectrum of the quartz mercury lamp. Sodalith, when excited by the longer ultra-violet waves, shows orange and faint yellow fluorescence; when excited by the shorter waves from 300 to 235 $\mu\mu$, it shows green. It shows orange in light passed through a Wood's absorption filter, which does not allow the shortest waves to pass. Certain specimens fluoresce brightly, others, from different localities, very faintly. The same applies to nosean and hauyne. One specimen of sodalith shows bluish-green fluorescence in place of orange. The mercury line at 365 is especially powerful in its effect upon the sodalith group of minerals. Excitation with Röntgen rays has no effect on this group. The sodalith minerals show very faint phosphorescence at room temperature, somewhat stronger at the temperature of liquid air. Of the minerals of the willemite group, typical brown willemite and phenakite show no trace of fluorescence, while some specimens of green troostite give a green fluorescence of a brilliance exceeded in the case of very few substances. The spectral region from 365 to 340 has no exciting effect upon troostite, not even the iron line at 344. The lines at 258·7 and 265·2 have especially strong effect. White troostite fluoresces less strongly than green, but is remarkable for the duration of its after-glow. The arc spectrum of this substance contains a strong beryllium line. Zinc oxide from Königshütte shows green fluorescence when excited by any portion of the ultra-violet region. Tephroite is strongly excited by the shorter wave-lengths only. Both troostite and tephroite are strongly fluorescent in Röntgen rays, while willemite from Altenberg shows no effect. The green variety of troostite is the most phosphorescent. Phenakite, white troostite, and tephroite are faintly phosphorescent. A table of arc spectra of the minerals examined is furnished by G. Eberhard. A. E.

1033. *Fluorescent Röntgen Radiation from Elements of High Atomic Weight.* **J. C. Chapman.** (Roy. Soc., Proc. Ser. A. 86. pp. 439–451, May 8, 1912.)—It is well known that when X-rays fall on various metals homogeneous characteristic or fluorescent radiations are emitted. When the elements of higher atomic weight than silver are examined under suitable conditions, it is found that there are two distinct types of radiation: one a penetrating characteristic radiation such as belongs to the elements of groups K [see Barkla, Abstract No. 684 (1912)], and, superposed on this a much softer radiation. Barkla and Nicol showed that in the cases of Ag, Sb, I, and Ba the softer radiations are homogeneous and characteristic as regards penetrating power, of the element emitting them. In the present paper elements of higher atomic weight have been investigated. The special difficulty with these elements is the magnitude of the purely scattered radiation, and this was eliminated by a special method which allowed it to be subtracted. The results of the experiments show that W, Au, Pt, Bi, Th, and Ur emit radiations which are homogeneous and characteristic of the elements. Further, these radiations belong to the same group as the soft radiations of Ag, Sb, I, and Ba termed by Barkla and Nicol Series L. The results show also that an empirical relation exists between atomic weights (W) of two elements which are in different groups but which would give out the same characteristic radiation. This relation is expressed by the formula $W_K = (W_L - 48)/2$. Thus an atom of atomic weight 79·5 would give the same characteristic radiation (homogeneous radiation of the same penetrating power) in the K series as an atom of atomic weight 207 (Pb) in the L series. It is also shown that the elements of Series L exhibit the same selective absorption phenomena in the neighbourhood of an absorption band as the elements of Series K; due to the characteristic radiation not being produced by a primary beam less penetrating than itself. E. M.

1034. *Absorption of Röntgen Rays in Air.* **A. S. Eve** and **F. H. Day.** (Phil. Mag. 23. pp. 683–688, April, 1912.)—If I is the ionisation current in an electroscope at a distance r from the source of rays, then I varies as $e^{-\lambda r}/r^2$, where λ is the absorption coefficient of the rays by air. Using this formula, the author has determined the absorption coefficients of the Röntgen rays from various tubes and at different distances from the bulbs. Secondary rays were measured and corrected for by completely absorbing the direct beam by lead plates. The results are :—

	Alternative Spark-gap.	λ.			
		4 to 10 m.	20 to 40 m.	40 to 60 m.	60 to 80 m.
Soft bulb	1·5 cm.	0·0018	—	—	—
Moderate bulb...	11 cm.	0·00040	0·00040	0·00029	0·00010 (?)
Hard bulb.........	30 cm.	0·00029	0·00027	0·00014	—

From calculations of the total number of ions produced the author deduces that the energy spent in ionising is only about 1/20000 of that expended in the bulb. E. M.

1035. *Ionisation by α-Rays.* **N. Campbell.** (Phil. Mag. 23. pp. 462–483, April, 1912.)—The present paper is in continuation of two previous papers on δ-rays [Abstracts Nos. 1502 (1911), 689 (1912)] and it is shown that information as to the nature of δ-rays may be obtained by allowing α-rays to fall on two electrodes with a p.d. between them sufficient to produce ions by collision. The results indicate that (*a*) There is no difference in the "emergent" and "incident" δ radiations from the same metal ; (*b*) the δ-rays excited by a given stream of α-rays in two different metals are the same in quantity and quality ; (*c*) the initial speed of δ-rays is small compared with that due to a fall in potential of 20 volts. The results are also discussed with reference to the theory of ionisation by collision and the author's views on this theory [Abstract No. 1081 (1912)]. It is concluded that in dry air an electron, in ionisation by collision rarely forms complex negative ions. The various conclusions are discussed as to the light they throw upon the mechanism of ionisation, the view being considered that the energy expended when gases are ionised is not expended directly in producing ionisation, but that it is expended on some other process of which ionisation is a by-product. E. M.

1036. *Number of Ions produced by an α-Particle from Polonium.* **T. S. Taylor.** (Phil. Mag. 23. pp. 670–676, April, 1912.)—The experiments consisted in measuring the saturation-current produced in an ionisation vessel by a limited beam of rays from polonium, the determination of the capacity of the measuring system, and the counting of the number of α-particles producing the ionisation current. The total ionisation was deduced from the area of the Bragg ionisation curve. The number of α-particles was determined by the scintillation method, the zinc sulphide screen being standardised by counting α-particles from RaC of known γ-ray activity. The mean value found for the number of ions produced per α-particle is 164,000, and this is in close agreement with the value already found by Geiger [Abstract No. 1547 (1909)]. The relative amount of energy of an α-particle required to produce an ion is calculated to be $5{\cdot}3 \times 10^{-11}$ erg. E. M.

1037. *Absorption of γ-Rays by Air at different Pressures.* **H. A. Erikson.** (Phys. Rev. 34. p. 231, March, 1912. Abstract of paper read before the Amer. Physical Soc., Dec., 1911.)—The γ-rays from Ra were passed through the Al windows of a heavy iron cylinder into which air was admitted at various pressures up to 200 atmos. The rays, after passage through the cylinder, entered a small ionisation chamber. The relation found between the pressure P and the intensity I was $I = I_0/1 + \mu D$, where μ is a constant. The constancy of μ was tested by using rays of different intensities. This formula is in agreement with the theoretical calculation of J. J. Thomson ("Conduction of Electricity through Gases," p. 407) on the assumption that only scattering of γ-rays takes place and no absorption. E. M.

1038. *Passage of γ-Rays of Radium through Matter.* **S. J. Allen.** (Phys. Rev. 34. pp. 296–310, April, 1912.)—The author has made a large number of detailed experiments on the absorption of γ-rays by different solids and liquids. It is shown that the coefficient of absorption of the γ-rays, as determined in the ordinary way by the ionisation method, depends greatly upon the experimental disposition of the various parts of the apparatus. The chief factors are: the position of the absorbing layer relative to the radium and the electroscope; the thickness and nature of the electroscope base; and the previous screening of the rays. This to a great extent explains the diversity of results furnished by past experimenters on this subject. The results of the author in this respect are thus in general agreement with those of Soddy and Russell. When the best arrangement suitable for the given case has been chosen, it is shown that the "stopping power per unit mass" (λ/ρ) is a function of the atomic weight of the absorbing material, increasing very slowly with the atomic weight until an at. wt. of about 100 is reached and then more rapidly. When the rays first pass through any substance before reaching the absorbing layer they are hardened (a smaller absorption coefficient). This hardening is a function of the at. wt. and is large for high at. wt. atoms. It is not proportional to the amount of absorption. The experiments also show that the absorption of the γ-rays by liquids is a function of the at. wts. of the constituent atoms, being an additive property of the atoms and independent of atomic grouping. Excluding the initial soft rays and with no previous hardening, the value of λ/ρ for all substances below an at. wt. of 100 may be taken for approximate calculations as 0·0410. The results are discussed as to their bearing on the various theories of γ- and X-rays, and further experiments are in progress to determine the absorptive properties of X-rays under similar conditions. E. M.

1039. *Distribution of the Active Deposit of Radium in an Electric Field.* **E. M. Wellisch** and **H. L. Bronson.** (Amer. Journ. Sci. 33. pp. 483–498, May, 1912. Phil. Mag. 23. pp. 714–729, May, 1912.)—Radium emanation was passed into a cylindrical vessel provided with a central electrode, and the distribution of the active deposit on the kathode and anode was determined for different pressures and potentials. The results indicate that there are on negatively-charged carriers, all the so-called anode activity being due to the diffusion of the uncharged carriers. The effect on the distribution obtained by causing Röntgen rays to pass through the gas was investigated; this effect was appreciable only when the activity and ionisation were far from saturation. It was found that the curve of variation of activity of the kathode resembles in many respects the curve of saturation of ionisation by α-rays. A theory is put forward to explain the difficulty in obtaining saturation in both cases, the assumption being that an α-particle produces "neutrons," or unstable systems which are subsequently resolved into ions, probably by collision with ions already established. E. M.

1040. *Weak Solutions of Radium.* **H. W. Schmidt** and **H. Nick.** Phys. Zeitschr. 13. pp. 199–207, March 1, 1912.)—The paper describes in detail the best methods for making standard measurements of radium by the emanation method. It has generally been thought that the emanation evolved from weak radium solutions diminishes with time owing to a supposed adsorption of Ra by the glass. The authors find no effect of this kind, however, with HCl solutions of pure Ra or Ra and Ba salts. The currents in absolute e.s. units produced per Curie of emanation in various cylindrical ionisation chambers were measured and found in good agreement with the values calculated from the empirical formula of Duane and Laborde [Abstract No. 926 (1910)]. E. M.

1041. *Diffusion of RaA Atoms.* **G. Eckmann.** (Jahrbuch d. Radioakt. 9. pp. 157–187, May, 1912.)—The experiments show that the atom of RaA is positively charged at the moment of its birth, although it may, in the presence of strong ionisation, afterwards become neutral or negatively charged. The coefficient of diffusion of the Ra atom in air was determined and found to be 0·06—a value close to that of Rutherford for RaEm. Special precautions were necessary in this experiment in order to obtain the RaA atoms free from aggregates. The result shows that the molecular weight of RaA is about equal to that of RaEm. E. M.

1042. *Penetrating Radiation at the Surface of, and in Water.* **D. Pacini.** (N. Cimento, 3. Ser. 6. pp. 93–100, Feb., 1912.)—The penetrating radiation found at the surface of the sea is always distinctly higher than that calculated from the radio-active substances known to be present in the air and water, showing the existence in the atmosphere of some influence producing ionisation with penetrating radiation, which is independent of the direct action of radio-active substances. Comparison of the fall of potential at the surface of the sea, and immersed to a depth of 3 m. shows that at the surface to be equivalent to 11 ions per cm.^{3} per sec., and that under the water to 8·9 ions per cm.^{3} per sec., a difference of 2·1 ions, whilst a similar comparison on Lake Bracciano gave 12·4 and 10·2 ions respectively. W. H. Si.

1043. *Light in Crystals.* **K. Försterling.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 2. pp. 217–239, 1912.)—A theoretical treatment of the propagation of light in absorbing active uniaxial crystals. E. H. B.

1044. *Total Reflection.* **W. v. Ignatowsky.** (Ann. d. Physik, 37. 5. pp. 901–910, April 16, 1912.)—A mathematical treatment on the electromagnetic theory. E. H. B.

1045. *Total Reflection Experiments.* **W. v. Ignatowsky** and **E. Oettinger.** (Ann. d. Physik, 37. 5. pp. 911–922, April 16, 1912.)—Describes experiments which on the whole confirm the theory developed by one of these workers. [See preceding Abstract.] E. H. B.

1046. *Photochemical Equivalent Law.* **A. Einstein.** (Ann. d. Physik, 37. 4. pp. 832–838, March 26, 1912.)—A thermodynamical treatment with certain assumptions which lead to Wien's law. E. H. B.

1047. *Abbe's Microscope Theory.* **O. Lummer** and **F. Reiche.** (Ann. d. Physik, 37. 4. pp. 839–844, March 26, 1912.)—Remarks on the paper by L. Mandelstam on the above subject. [See Abstract No. 1475 (1911).] E. H. B.

1048. *Field of the Poynting Vector in the Interference of Two Plane Light Waves in an Absorbing Medium.* **S. Boguslawski.** (Phys. Zeitschr. 13. pp. 394–397, May 1, 1912.)

1049. *The Theory of Spectral Series.* **H. A. Wilson.** (Phil. Mag. 23. pp. 660–663, April, 1912.)

1050. *Spectra of Transmission Grating.* **M. Wolfke.** (Ann. d. Physik, 37. 4. pp. 797–811, March 26, 1912.)—Mathematical. [See Abstracts Nos. 616 (1911), 713 (1912).] E. H. B.

1051. *Spectra of Aromatic Compounds in Ultra-violet Light.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 14. 9. pp. 493–505, May 15, 1912.)—A continuation of the author's work previously dealt with [Abstract No. 717 (1912)]. Experiments are described which show that the substances used undergo physical change when subject to short-wave ultra-violet light, such as that obtained by using the Zeiss UV-filter. A. W.

1052. *Absorption Spectra of Permanganates.* **W. N. Hartley.** (Chem. Soc., Journ. 101. pp. 826–830, May, 1912.)—Attention is directed to the possible influence of hydrolysis upon the absorption spectra of permanganates. T. M. L.

1053. *Fluorescence of the Platinum Double Salts.* **J. Beuel.** (Zeitschr. wiss. Phot. 11. pp. 150–168, May, 1912. Extract from Dissertation.)—The fluorescence of the various double cyanides of Pt and the substances Ba, Sr, Ca, Na, K, Mg, NH_4, Li, was investigated both for solutions and for the salts themselves under the influence of ultra-violet light and of kathode rays. A table is given of the relative intensities of the bands in the fluorescence spectra obtained. A. W.

1054. *Decay Constant of Radium D.* **P. Rossi.** (Accad. Lincei, Atti, 21. pp. 462–467, April 14, 1912.)—From measurements of the loss of activity of Vesuvian cotunnite, the author concludes that the mean half-period of RaD is about 17 years. [See also Abstracts Nos. 1518 (1907) and 1258 (1910).] W. H. St.

1055. *Radium-content of Uranium Minerals.* **W. Marckwald** and **A. S. Russell.** (Jahrbuch d. Radioakt. 8. pp. 457–470, Jan., 1912.)

1056. *Radium-content of Secondary Rocks.* **A. L. Fletcher.** (Phil. Mag. 23. pp. 279–291, Feb., 1912.)

1057. *Radio-activity of the Rocks of the St. Gothard Tunnel.* **J. Joly.** (Phil. Mag. 23. pp. 201–211, Feb., 1912.)

1058. *Radium-content of Rocks.* III. **E. H. Büchner.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 1063–1066, April 25, 1912.)—This part deals with rocks from Borneo, the Moluccas, and the Dutch province of Limburg.

1059. *U.V. Filter and U.V. Filter Lamp in the Analysis of Luminescence.* **H. Lehmann.** (Zeitschr. Instrumentenk. 32. pp. 43–54, Feb., 1912.)

HEAT.

1060. *Absolute Expansion of Mercury.* **H. L. Callendar.** (Phil. Mag. 23. pp. 679–683, April, 1912.)—This is a reply to the paper by Scheel and Heuse [see Abstract No. 729 (1912)], at least to that part referring to temperatures 0° to 100° C. Callendar points out that the results of Thiesen, Scheel, Sell, and Chappius, when used in conjunction, all labour under one or more of the following objections: (1) The bulbs and rods used may have differed in composition; (2) they may have differed in expansion owing to different form or treatment; (3) the axial and radial expansions may not have been identical. Again, Thiesen's results for the absolute expansion of water, which have been adduced by Scheel and Heuse, are not accurate enough for the purpose. The expansion of silica has also come into this discussion, and Callendar shows that if the minimum value for a silica tube radially is at 0° about, corresponding to the minimum value from —50° to —80° for a silica rod, his results would be confirmed. Possible errors in the determination of the absolute expansion of mercury are now being reconsidered, and observations with the silica weight-thermometer at higher and lower temperatures are being made. P. E. S.

1061. *Expansion of Mercury and Quartz.* **N. Eumorfopoulos.** (Phil. Mag. 23. pp. 653–655, April, 1912.)—This paper arises out of one by Scheel and Heuse [see Abstract No. 729 (1912)]. Eumorfopoulos considers that the coefficient of thermal expansion, as found by Callendar and Moss, is too low, at all events below 100°. He bases this view on the value for the coefficient of expansion of quartz as found by using the coefficient for mercury as determined by Callendar and Moss. By a critical examination of the coefficients of water found by Chappius, the author concludes, with Callendar and Moss, that the cubical expansion should not be calculated from the linear expansion. P. E. S.

1062. *Dilatability of Commercial Nickel.* **C. E. Guillaume.** (Comptes Rendus, 154. pp. 748–751, March 18, 1912.)—The discovery of the anomalous behaviour in the dilatation of nickel steels threw some doubt on the use of nickel for standards of length. Observations of the dilatation of various nickel bars during the period from 1891 to 1911 have shown that the average value of α in the dilatation equation since 1898 was $12{\cdot}584 \times 10^{-6}$. The dilatability of nickel has diminished considerably in the last 20 years, and it can now be neglected over an interval of 20° C. so long as the accuracy need not exceed 0·4 μ per metre. F. C. A. H. L.

1063. *Measurement of Specific Heats of Metals at High Temperatures.* **O. M. Corbino.** (Accad. Lincei, Atti, 21. pp. 181–188, Feb. 4, 1912. Phys. Zeitschr. 13. pp. 375–383, May 1, 1912.)—A new electrical method for the measurement of specific heats of metals at high temperatures is described, based on the determination of the ratio c/a, where c is the specific heat, and a the coefficient of variation of resistance with change of temperature. This ratio is obtained by studying, with the Wheatstone bridge, the rate of change of temperature in a filament of the metal caused by a small and sudden

diminution in the resistance of the circuit containing the filament. The method is of almost unlimited sensibility, and applied to a 82-c.p. Osram lamp, gave the values of *c/a* as 4·0, and 4·88 at 95 and 108 volts respectively.
W. H. Si.

1064. *Thermal Constants of Tungsten at High Temperatures.* **O. M. Corbino.** (Accad. Lincei, Atti, 21. pp. 188–194, Feb. 4, 1912. Phys. Zeitschr. 18. pp. 875–888, May 1, 1912.)—Employing the method recently described [see preceding Abstract], the author has measured the values of *c/a* for a 50-c.p. tungsten lamp at p.d.'s ranging from 10·9 to 109·0 volts, with the following results :—

Tension. Volts.	Resistance, taking that at 20° C. = 1.	Temperature.	*c/a*.	$a \times 10^4$.	$c \times 10^4$.
10·9	4·74	800°	4·6	12·4	57·0
22·00	6·3	1050	6·0	9·4	56·4
29·2	7·3	1250	6·9	8·1	55·9
49·2	8·7	1450	8·4	6·7	56·3
94·5	11·3	1800	11·4	7·5	85·5
109·00	11·7	1850	11·8	7·6	89·7

The above temperatures are taken from v. Pirani's results connecting resistance and temperature [Abstract No. 827 (1910)], and the two last, which were obtained by extrapolation, are open to doubt. Up to 1500° C., however, the specific heat of the filament remains constant, and probably also up to 2000°, in which case the determination of *c/a* may be used pyrometrically to measure the actual temperature of the filament. (Ibid. pp. 846–851, March 8, 1912.)—More accurate methods of measurement show that the values of *c/a* given above are about 8 per cent. too high, and applying the formula of Nernst and Lindemann, the specific heats at constant volume are deduced from those obtained at constant pressure. The latter are found to be nearly proportional to dr/dt, and since c_v may be regarded as a constant up to 2000°, the resistance-temperature curve up to that point should be rectilinear. From a direct weighing and measurement of the filament its atomic heat is found to be 7·8, which is only slightly higher than Defacqz and Guichard's result of 7·1, and it is concluded that tungsten behaves abnormally between 15° and 800° C. [See also Abstract No. 1167B (1911).] W. H. Si.

1065. *Ratio of the Specific Heats, and the Specific Heats at Constant Pressure of Air and Carbon Dioxide.* **H. W. Moody.** (Phys. Rev. 34. pp. 275–295, April, 1912.)—The method used in this investigation depends on the law of adiabatic expansion of gases. Taking p and θ as variables, the adiabatic expansion of a perfect gas from an initial pressure p_1 to a final pressure p_2 is expressed by $(\theta_1/\theta_2)^\gamma = (p_1/p_2)^{\gamma-1}$, where θ_1 and θ_2 are the absolute temperatures before and after expansion, and γ is the ratio of the specific heats at constant pressure and constant volume. The above equation gives—

$$\gamma = \log(p_1/p_2)/[\log(p_1/p_2) - \log(\theta_1/\theta_2)].$$

A special device is described for arriving at the instantaneous temperature assumed by the gas in the adiabatic expansion, this temperature changing rapidly owing to heat flowing in from the walls of the surrounding vessel.

The results show that at 20° and 760 mm., $\gamma = 1\cdot4011$ for air and 1·3008 for CO_2, the probable error in each case being $\pm 0\cdot0005$. These values agree well with those given by the best determinations of recent years, although the value for air is smaller than was obtained in certain earlier investigations usually regarded as reliable. Computation on the basis of the first and second laws of thermodynamics and from the best available data gives for air the value $C_p = 0\cdot24118$ at 20° and 760 mm., and there is little doubt that the values hitherto accepted are too low. For CO_2 under similar conditions, the value $C_p = 0\cdot2008$ is obtained; this agrees within the limits of error with the results of Lussana's measurements, and is slightly lower than the numbers given by other reliable determinations. T. H. P.

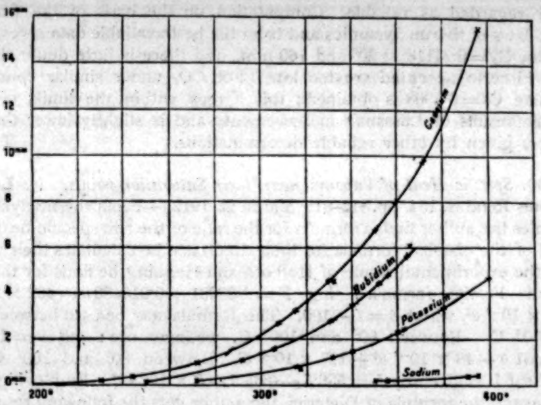
1066. *Specific Heat of Vapours near their Saturation-points.* **A. Leduc.** (Comptes Rendus, 154. pp. 812–815, March 25, 1912.)—From thermodynamical principles the author finds a formula for the ratio of the two specific heats. By the aid of the classical formula for their difference he calculates their values. Using the experimental results of Holborn and Henning, he finds for the max. pressure F the formula: $\log F = 1\cdot88081 + 0\cdot015486\,\theta - 462 \times 10^{-7}\,\theta^2 + 108 \times 10^{-9}\,\theta^3$, where $\theta = t - 100$. This formula may be used between 100° and 160° C. Between 80° and 100° C. we may use: $\log F = 1\cdot88081 + 0\cdot01551\,\theta - 48 \times 10^{-6}\,\theta^2 + 127 \times 10^{-9}\,\theta^3$. Between 80° and 160° C. the latent heat L is given by $L = 538\cdot5 - 0\cdot65\,\theta + 8 \times 10^{-4}\,\theta^2$. Employing these formulæ and the formula of Dieterici, the author gets the following results:—

t° C.	γ.	C.	c.
160	1·367	0·521	0·381
150	1·375	0·492	0·358
140	1·380	0·471	0·342
130	1·382	0·455	0·329
120	1·381	0·445	0·322
110	1·377	0·439	0·319
100	1·372	0·435	0·318
90	1·367	0·433	0·317
80	1·362	0·431	0·316

Here C and c are the two specific heats, and γ their ratio. The values of γ in the above table agree closely with the formula: $\gamma = 1\cdot372 + 5 \times 10^{-4}\,\theta - 2 \times 10^{-6}\,\theta^2 - 13 \times 10^{-8}\,\theta^3$. A. R.

1067. *Vapour Tension of Alkaline Metals between 250° and 400°.* **L. Hackspill.** (Comptes Rendus, 154. pp. 877–880, April 1, 1912.)—Jewett [see Abstract No. 554 (1903)] has measured the densities of the saturated vapour of Na between 368° and 420°. In the present research two vertical tubes (250 mm. high and 8 mm. diam.) were used; these were connected at their lower ends by a horizontal capillary 2 to 3 mm. diam., and after the introduction of the metal were sealed at their upper extremities, so that the difference in level depended not only on the difference of density, but also on the vapour tension of the metal. One branch being maintained at $t°$, a little higher than the point of fusion, for which temperature the tension is negligible, and the other at $t'°$ $(>t)$, the pressure p is given in mm. of Hg by the relation $p = (D_r/13\cdot595)\left[\{h/(1 + a.\overline{t - f})\} - \{h'/(1 + a.\overline{t' - f})\}\right]$, h

and h' being the heights of the columns of metal above the horizontal tube, D_f the density of the molten metal at the point of fusion f, and α its expansion coefficient. The results are shown in the diagram. The determinations of the density of the vapour, which will be published shortly, have not given results as concordant as for the vapour tension; they show, however, that Rb and K are monatomic, and they further give, by application of Clapeyron's formula, an idea of the latent heats of vaporisation of the alkaline metals. A. W.



1068. *Imperfection of the Gaseous State.* **U. Ciampini.** (N. Cimento, 3. Ser. 6. pp. 101–127, Feb., 1912.)—Tumlirz's formula, $p(v + a) = RT$, for the characteristic equation of a body, is shown to be invalid, values deduced therefrom differing from those observed experimentally between 311° and 375° by 20, 30, and even 40 per cent. Battelli's results with carbon disulphide, ether, and alcohol at low temperatures, and with water, are considered mathematically, various "characteristic lines" being described, and illustrated with diagrams. W. H. Si.

1069. *Complete Radiation.* **S. B. McLaren.** (Phil. Mag. 23. pp. 513–542, April, 1912.)—A theoretical paper reaching the following conclusion: "It thus appears that with no continuous laws of motion is it possible to account for the actual distribution of energy. The proof, however, involves the assumption that the statistical method applies to the ether with its infinity of degrees of freedom. By the direct method of the present paper it is shown that for any material system equipartition follows if the principle of least action is assumed." E. H. B.

1070. *The Virial of a Mixture of Ions.* **S. R. Milner.** (Phil. Mag. 23. pp. 551–578, April, 1912.)—Mathematical.

1071. *Application of Theory of Chemical Potential to Thermo-dynamical Theory of Solutions. II. Effect of Pressure on Vapour-pressure.* **S. A. Shorter.** (Phil. Mag. 23. pp. 483–494, April, 1912.)—Mathematical.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1072. *Air-earth Currents and Earth Currents, and their Connection with Variations of Terrestrial Magnetic Elements.* **A. Gockel.** (Terrestrial Magnetism, 17. pp. 1–20, March, 1912.)—Continuous records of potential gradient in the atmosphere have been regularly obtained for many years, but it is only recently that the conductivity and the number of ions per unit volume have been made the subjects of continuous registration and publication; so that changes in the air-earth current, which is obtained by multiplying the potential gradient and conductivity, have hitherto been little studied. The variations in potential gradient and conductivity are found to be everywhere in opposite senses, so that the variations in air-earth current are less pronounced than those of either of the other elements, but they are not dissimilar in general outline to those of potential gradient alone. The author endeavours to answer the question whether a part, at least, of the earth's magnetism is due to electric currents in the lower layers of the air, by noting if variations in the magnetic field and the air-earth current are simultaneous. Both the mean diurnal variation of vertical magnetic force and air-earth current show marked minima in the early afternoon hours, except in winter, when the electric variation is different. The mean seasonal variation of air-earth current shows a maximum in winter and a minimum in summer. If curves for the same place and year are compared, it appears that the seasonal variations of air-earth current and of horizontal and vertical magnetic force are similar, but the shapes of the curves vary considerably in different years. There is, however, no unmistakable connection between magnetically and electrically disturbed days; indeed, such a connection is improbable, since magnetic disturbances are almost, if not quite, simultaneous all over the earth, while electric disturbance depends considerably upon local weather. Since the earth-current depends upon the air-earth current, it is to be expected that similar relations to those mentioned above exist between variations in the earth current and the magnetic elements. Thus the mean diurnal variation of earth current is closely parallel to that of vertical magnetic force. If curves for individual days are compared, however, the resemblance disappears on highly disturbed days, and is only partially evident on quiet days. R. C.

1073. *Air Conductivity over the Pacific Ocean.* **A. Nippoldt.** (Terrestrial Magnetism, 17. pp. 33–41, March, 1912.)—[See Abstract No. 1997 (1908).] Observations of absolute electric conductivity were made by P. H. Dike on board the *Galilee,* in the Pacific Ocean, from Aug., 1907, to May, 1908. The observations were made throughout by means of a Gerdien apparatus. The *Galilee* started from Alaska, and passed the Hawaiian Islands, Midway Island and Marshall Islands, to New Zealand. From thence the course was laid due east, and then north-east to Callao in Peru, and finally to San Francisco, the course between the last two ports being about 1000 miles from the coast-line. The observations were sorted according to the particular

10-degree square in which the ship happened to be, and the values for each square were averaged. From this it became evident that the variation of conductivity along any parallel of latitude is very small, but that the variation along a meridian is considerable. Taking the mean of all the observations along every parallel and comparing all the means so obtained, it appeared that the conductivity varies fairly regularly from $4{\cdot}0 \times 10^{-4}$ e.s. units at 50–60° N. to $2{\cdot}6 \times 10^{-4}$ at 40–50° S. The author compares the figures with the values of the relative areas of land and water at the corresponding latitudes, in the hemisphere of the earth of which the middle point lies on the Equator in 150° W. Long., *i.e.*, the hemisphere which includes the Pacific Ocean most nearly. The comparison reveals a similarity between the curves of relative land area and of conductivity, and the suggestion is put forward that although the course of the ship was usually thousands of miles from a continent, the relative areas of land and water are related with the variation of the conductivity of the air in the several latitudes. R. C.

1074. *Electric Charge of Rain.* **A. Baldit.** (Comptes Rendus, 154. pp. 731–733, March 11, 1912. Le Radium, 9. pp. 92–101, March, 1912.)—Previous work [see Abstract No. 1197 (1911)] confirmed the observations of Simpson and Kähler that rainfall usually brings down with it positive electricity, occasions when negative charges are observed being comparatively rare. Further observations at Puy-en-Velay give the following results: Ratio of duration of positively-charged rain to negatively-charged is 2·86; ratio of quantity of rain positively charged to that negatively charged is 2·38; ratio of total positive charge to total negative charge is 1·36. The rains were subdivided into three classes: (1) non-stormy, (2) stormy, (3), line-squall, and the above ratios were computed for each class. Class (1) gave the highest ratios, 5·3, 4·3, and 2·3 respectively; and Class (3) the lowest, 1·1, 1·2, 1·1, showing that quiet rain is associated with positive electricity, and that the rain of line-squalls is frequently charged negatively. Further, it appears that the average negative charge brought down per unit volume of rain is considerably greater than the average positive charge. After lightning, great fluctuations occur in the charge brought down, the sign of the charge being frequently reversed. R. C.

1075. *Ionising Action of Ultra-violet Light.* **H. Dember.** (Phys. Zeitschr. 13. pp. 207–212, March 1, 1912.)—Laboratory experiments show that ultra-violet light increases both the electric conductivity of air through which it passes, and also the number of ions of both signs per unit volume of air. The ultra-violet light from the sun is absorbed by the higher layers of the atmosphere, so that the change in conductivity due to variations in the intensity of the light is not observed at low levels. The author made observations for a fortnight in 1911 of the numbers of positive and negative ions per m.^{3} throughout the day from sunrise to sunset, and of the intensity of short-wave radiation at two high-level stations in Switzerland, at altitudes of 2000 m. and 3420 m. The measurements of the numbers of ions were made with Ebert's apparatus; those of intensity of ultra-violet light were obtained from observations of the rate at which a negative charge was dissipated from a bright magnalium disc exposed to the rays. The results show a marked diurnal variation in the number of ions, corresponding with the variation in the intensity of the light; the max. number of ions usually occurring in the afternoon, an hour or two after the max. intensity. The stations were thus in a region where ultra-violet light was sufficiently powerful to influence appreciably the conductivity of the air. Observations of humidity, made at the same time, do not support the hypothesis that humidity affects the electric conductivity in any direct way. R. C.

1076. *Electrons, Relativity Principle and the Ether.* **L. Zehnder.** (Deutsch. Phys. Gesell., Verh. 14. 8. pp. 438–448, April 30, 1912.)—A general discussion of these topics. E. H. B.

1077. *Electrodynamics.* **M. Petrovitch.** (Journ. de Physique, 2. Ser. 5. pp. 281–288, April, 1912.)—Treats the phenomena of electrodynamics and electromagnetics by the minimum theorem. E. H. B.

1078. *Ion-content of the Atmosphere over the Atlantic.* **G. Berndt.** (Phys. Zeitschr. 12. pp. 857–865, Oct. 15, 1911.)

1079. *Electric Conductivity of the Air between the Chilean Coast and the Easter Islands.* **W. Knoche.** (Phys. Zeitschr. 13. pp. 822–832, April 15, 1912.)

DISCHARGE AND OSCILLATIONS.

1080. *Effect of a Magnetic Field on Photoelectric Emission.* **A. W. Hull.** (Phys. Rev. 34. pp. 239–240, March, 1912. Abstract of paper read before the Amer. Physical Soc., March, 1912.)—Photoelectric emission from an Al plate in a high vacuum is reduced to a small fraction of its value by a magnetic field perpendicular to the plate. This effect increases with the strength of the field, but is greatly diminished by an electric field in such a direction as to drag the electrons from the plate. Thus, in the absence of an electric field, a magnetic field of 100 gauss reduced the photoelectric emission to one-twentieth of its value ; with an electric field of 2 volts/cm. the same magnetic field reduces the emission to one-half its value. Experiments so far show the effect of the magnetic field to be independent of the nature of the gas or the thickness of the layer. J. J. S.

1081. *Ionisation by Collision.* **N. Campbell.** (Phil. Mag. 23. pp. 400–412, March, 1912.)—The paper consists of a critical discussion of the physical assumptions in Townsend's theory. It is pointed out that Townsend's argument contains an error in the assumption that the proportion of the ions passing through any given layer, which have travelled freely a distance sufficient to enable them to ionise at their next collision, is constant and independent of the position of the layer. The assumption is not true for layers nearer to the electrodes than the distance required for an ion to travel under the electric field before it can ionise. New formulæ are obtained and found to agree better with Townsend's measurements. Formulæ are also obtained based on the view that a negative ion after collisions with neutral molecules becomes a complex ion. **J. S. Townsend.** (Ibid. pp. 856–859, May, 1912.)—A reply to Campbell. E. M.

1082. *Monomolecular Carriers of Electricity in Gases and a New Method of Measuring the Diameter of a Molecule.* **W. Altberg.** (Ann. d. Physik, 37. 5. pp. 849–880, April 16, 1912.)—When a gas is made conducting by the action of kathode rays a unit of negative electricity is separated from the gas molecule to become afterwards attached to another molecule. It is therefore to be expected that the ions so formed should possess mobility corresponding to molecular magnitude. Experiments show, however, that while a small proportion possess mobility even greater than this, by far the larger number behave as if they were of more than molecular size. If it can be shown that this smaller velocity is due to the subsequent loading-up of the charged particle, then, according to the researches of A. Becker, this must occur within 0·35 sec. of their origin. The gauze condenser method, which consists essentially in finding the e.m.f. required to drive the charged particle against a stream of air of known velocity, is the best to employ for investigating the quickest ions, and is here adopted. The special form of apparatus used and the general experimental arrangements are described, the possible sources of error being considered. Experiments are carried out at different gas velocities with constant gauze distance and also with gas velocity and gauze distance both varying. A table giving details of the mobility of positive and negative ions in CO_2, air, oxygen, and nitrogen is included. There is a mathematical investigation of Lenard's formula to adapt it to the case of a mixture of gases. From the table it is apparent that the total effect in air is about 200 times greater than in commercial hydrogen, so that although the absorption of Röntgen rays is approximately proportional to the density this is not the case with the formation of ions. In pure hydrogen the approximate value for the mobility of the ions is found to be 105 for positive and 152 cm. sec.^{-1} volt cm.^{-1} for negative. Calculating from these values, the radius of the positive ion in hydrogen is $7·95 \times 10^{-9}$ cm., and that of the negative $4·8 \times 10^{-9}$ cm.

A. E. G.

1083. *Effect of Clouds on Ionisation.* **G. Owen** and **J. H. T. Roberts.** (Phil. Mag. 23. pp. 352–367, March, 1912.)—The problem investigated is the effect of suspended particles upon the ionisation current in air, the ionising agent being the γ-rays of radium. As suspended particles the authors have used the cloud particles formed when moist, ionised, dust-free air is subjected to adiabatic expansion, the method giving particles of uniform size and constant number, both factors being also readily controllable. The results show that the ionisation current in cloud-laden air is smaller than in cloudless air, the reduction depending on the electric field used and the density of the cloud. When the percentage diminution of the current reaches a certain value, about 75 per cent., any further increase in the density of the cloud does not result in any further reduction of the ionisation current. For this reason a cloud produced on equal numbers of positive and negative ions has very little greater retarding effect than the cloud produced on the negative ions alone. The method gives an illustration of the results of C. T. R. Wilson on the effects of adiabatic expansions of various magnitudes, and also shows that the number of nuclei of Wilson's foggy condensation caught by an expansion greater than 1·38 is greatly reduced by the presence of ions in the gas.

E. M.

1084. *Ionisation by Moving Particles.* **J. J. Thomson.** (Phil. Mag. 23. pp. 449–457, April, 1912.)—The theory developed in this paper is based on the following assumptions: (1) Kathode or positive rays when they pass through an atom repel or attract the corpuscles in it and thereby give to them kinetic energy. (2) When the energy imparted to a corpuscle is greater than a certain definite value—the value required to ionise the atom—a corpuscle escapes from the atom, and a free corpuscle and positively-charged atom are produced. The circumstances under which a kathode ray moving with a given velocity will lose, when it passes by a corpuscle, a quantity of energy greater than the amount required to ionise an atom are first considered. If d is the length of the perpendicular from the second particle on the direction of projection of the first, T the kinetic energy of the first particle; then, if the corpuscle requires an amount of energy W to escape from the atom, in order that the atom should be ionised by the kathode particle, d must not be greater than the value given by $d^2 = (T/W - 1)e^4/T^2$. If n is the number of corpuscles in the atoms in unit volume of the gas, the number of collisions for which d is not greater than this value made per cm. by a corpuscle moving through the gas is $n\pi d^2$, *i.e.*, $(n\pi e^4/T^2)(T/W - 1)$. This is a maximum when $T = 2W$. When, as in the case of β-rays or kathode particles in a vacuum tube, T is large compared with W, the expression reduces to $n\pi e^4/WT$, so that the number of ions produced per cm. by a kathode particle on this theory varies as 1/T. Glasson's results are in accord with this theory. Calculations given show that unless the value of W is very far out, the number of corpuscles in an atom is not greater than 2 or 3 times the atomic weight. From the relative values of Q calculated for several gases it appears that hydrogen is much more easily ionised than any of the other substances tried by Kleeman. The number of ions made per cm. of path by the action of the positively-charged particles on the negative corpuscles is when T′ (kinetic energy of a corpuscle moving with the velocity of the positive particle) is large compared with W, $n\pi e^2E^2/WT'$, so that when $e = E$ the number of ions produced by the positively-electrified particle is the same as that produced by a corpuscle moving with the same velocity. In order that a positively-charged particle may ionise the gas at all T′ must be greater than W/4; thus if we take W to be 10 volts T′ must be at least 2·5 volts. If the positively-charged particle were an atom of hydrogen T′ must be 2·5 × 1700 or 4250 volts, and so on. Thus unless the p.d. between the terminals in a vacuum tube is very large it will only be the atoms and molecules of the lighter gas which can produce ionisation in this way. According to this view it is the velocity of the positive particle and not its energy which must exceed a critical value before it can ionise a gas, and with a knowledge of this critical value W can be found. It is hoped by isolating (by means of magnetic and electric deflection) positive rays of definite character and velocity, to get information on this point. It is shown that the character of the radiation emitted during the recombination of the ions will be a series of pulses, each pulse containing the same amount of energy, and of such a character that if the electromagnetic disturbance is analysed by Fourier's theorem into a system of harmonic vibrations, the distribution of energy among the different periods will be the same for each pulse. In fact, each pulse will form a unit or quantum, and the total radiation will be built up of such units. The maximum energy for light analogous in its properties to the radiation emitted by the recombination of the ions would be in the neighbourhood of wave-length $8{\cdot}8 \times 10^{-6}$ cm., and would thus correspond to light very far in the ultra-violet. The theory is supported by the fact that those regions in a discharge-tube where recombination is taking place, such as the negative glow, are the sources of a type of radiation called "Entladungstrahlen" which has many of the properties of ultra-violet light. It is further shown that the presence in the atom of systems requiring a large quantity of energy to ionise, would give rise to Röntgen radiation of a type determined solely by the properties of the atom. The energy in this radiation would be divided into definite units or quanta; the character of the radiation when excited would be independent of the means used to excite it, but it would not be excited unless the velocity of the primary kathode rays exceeds a critical value. This radiation has all the properties of the "characteristic Röntgen radiation" discovered by Barkla. The existence of systems which are first dissociated and then restored to their original condition by the falling-in of a corpuscle carrying with it kinetic energy, will also explain the diminution of specific heat with temperature. A. E. G.

1085. *Kathode Rays of Small Velocity produced in Incandescent Lamps.* **L. Houllevigue.** (Comptes Rendus, 154. pp. 1221-1223, May 6, 1912.)—The author has previously shown [see Abstracts Nos. 922, 1204 (1911)] that it is possible to see kathode rays in the bulb of an incandescent carbon-filament lamp. The object of the present experiments is to prove that the pencil of rays obeys the electromagnetic laws. For this purpose the apparatus is placed in a uniform magnetic field acting perpendicular to the luminous pencil, and the result obtained confirms that supposition. If e/m be taken as $1{\cdot}86 \times 10^7$, the velocity of the electrons calculated from the experimental data is $55{\cdot}05 \times 10^7$ cm./sec., while calculated from the known fall of potential it is $68{\cdot}4 \times 10^7$ cm./sec. A. E. G.

1086. *Electrical Experiments with Mercury contained in Tubes.* **J. H. Vincent.** (Phil. Mag. 22. pp. 506-538, Oct., 1911.)—Five luminous effects are dealt with by the author. They are: (1) Persistent illumination in which a mercury arc increases and decreases in length rhythmically. (2) Periodic illumination in which the arc is intermittent. (3) Persistent illumination in which the arc is of constant length. (4) The emission of a faint bluish-green light from a space containing liquid mercury and its vapour. (5) Phosphorescence of fused quartz. The first three are discussed at greater length, under the names (1) Necklace, (2) Fan, and (3) Ribbon effect, respectively, corresponding to the appearance observed on viewing the arc in a revolving mirror whose axis of rotation is parallel to the tube in which the arc occurs. The fourth effect is called the "green glow." For details the original pages should be referred to. L. H. W.

1087. *Distribution of Current in Point-plane Discharge.* **R. F. Earhart.** (Phys. Rev. 34. pp. 187-200, March, 1912.)—An examination of the appearance of the luminous discharge in tubes of moderate vacuum shows that small changes in pressure and potential produce great differences in luminosity under certain conditions. This is particularly true when one of the electrodes is a plate and the other electrode a point or small sphere. In the region of critical pressure for the distance separating the electrodes the variations are quite rapid. When the plate is made the kathode there is a limited range of pressures where a change of 1 per cent. in potential will convert a feeble insignificant discharge confined to a limited area of the plate into a brilliant discharge in which a large area of the plate is covered with a luminous layer of gas, the current increasing many fold. The purpose of the present investigation is to study the variations in intensity of current with pressure, potential and distance, but especially the distribution of current. To this end the distribution of the discharge over a plate occurring between a point and that plate for five distances, viz., 0·5 cm., 1 cm., 2 cm., 3 cm., 4 cm., and for several voltages is found. Nine brass rings are mounted concentrically about a brass rod; these are set into a rubber plate. The conducting zones are of equal width (5 mm.), each one being separated from its neighbour by a ring of rubber insulation 2 mm. wide. Arrangements are made so that it is possible to determine the current passing through any of the rings. The "point" consists of a hemisphere turned on a Pt rod of 1 mm. radius. Air which is thoroughly dried is the only gas used. Fresh gas is a much better conductor than a gas which has undergone continued discharge. Above the critical pressure there is a gradual increase in the total current with pressure until a maximum is attained. This maximum does not occur at the same pressure for all voltages. In general, the higher the voltage the greater is the pressure at which the maximum is reached. As the pressure is approached at which the potential is insufficient to maintain the discharge there is a decrease in the value of the current. For pressures exceeding the critical pressure the area of the plate functioning in the discharge is limited to a small solid angle, while for pressures less than the critical pressure a larger portion of the plate comes into play. The minimum potential required to produce a discharge from the negative point is about 350 volts at the critical pressure, and a potential not very different from this will maintain a current at higher pressures. The increase in potential necessary to maintain a current grows very slowly with increase in pressure for a time, and then increases quite rapidly. The greater the distance separating the plates the more rapid is the increase. It is much easier to start a discharge with the point negative than with the plate negative, but once the discharge has started a somewhat lower potential will suffice for maintenance when a plate is negative. It is found, for the range of pressures considered, that the currents for plate kathode for the same potential and pressure are greater when the distance separating the electrode is 4 cm. than for smaller distances. At lower pressures where the current is small, all parts of the plate take part in the discharge, and with increase in pressure the current increases over all portions of the plate, but the rate of increase is greater on the outer zone. The silent discharge in moderate vacuum bears some points of resemblance to the electric arc. A. E. G.

1088. *Electric Transport of Matter in Vacuo by the Mercury Vapour Arc Light.* **W. Matthies.** (Ann. d. Physik, 37. 4. pp. 721–738, March 26, 1912.) —Perot has published results which apparently show that independent of all vaporisation there is a direct electric transport of positively-charged Hg atoms from the anode to the kathode of the mercury arc light [see Abstract No. 1560 (1911)]. The results of the present experiments indicate that no such electric transport of matter occurs in the mercury arc. The current is carried not by Hg ions, but is a pure unipolar electron current. The pressure which is set up at the Hg anode has nothing to do with the electric current as such, but is produced solely by the more or less intense vaporisation of Hg taking place at the electrode. Hence it appears that Perot's explanation of the mechanism of the luminosity in the mercury arc needs revision so far as the positive Hg ions as carriers of the current are concerned. A. E. G.

1089. *Condenser Discharge.* **A. Aubertin.** (Comptes Rendus, 154. pp. 874–877, April 1, 1912.)—It is possible, at atmospheric pressure, to obtain spark discharges of a condenser of very varied form, from the aspect of a discharge in a Geissler tube to that of the white disruptive spark. The Geissler discharge can be obtained between metallic electrodes of very small capacity and distant about 0·5 to 1·0 mm., when the current is led to the electrodes by conductors of very high resistance. The electrodes used were two bits of Pt-wire, 0·3 mm. diam. and 1 cm. long, rounded at their ends and fused into glass tubes 3 to 4 mm. diam. Two tubes, filled with water or with $CuSO_4$, served for high resistances, and the condenser consisted of several Leyden jars, charged by a Holtz machine. The discharge was observed with a microscope. Photographs are reproduced and the appearance as the resistance in circuit is gradually decreased is described in detail. The same succession of appearances is obtained with small capacities as with larger ones, only less brilliant. The sparking potentials corresponding to the Geissler discharge and to the disruptive discharge are little different. The Geissler spark does not completely discharge the condenser. There remains a p.d. between its terminals which is greater the greater the resistance of the discharge circuit. For example, the initial p.d. being 2000 volts, the spark causes a diminution of this difference of about 950 volts if the resistance of the circuit is that of a water column 10 cm. long; by 500 volts for 20 cm. of water; and 250 volts for 50 cm. of water. Villard has observed similar phenomena in gas tubes at low pressure for longer discharges. A. W.

1090. *The Charges on Ions.* **J. S. Townsend.** (Phil. Mag. 23. pp. 677–679, April, 1912.)—A criticism of Pomeroy's experiments (see Abstract No. 547 (1912)].

1091. *Rays of Positive Electricity from the Wehnelt Kathode.* **C. T. Knipp.** (Phys. Rev. 34. pp. 215–223, March, 1912.)—A more complete account of the method and apparatus used [see Abstract No. 555 (1912)], with additional data.

1092. *The Marconi Bent Antenna.* **H. Hoerschelmann.** (Jahrbuch d. Drahtlosen Telegraphie, 5. pp. 14–34, Sept., and pp. 188–211, Nov., 1911. Extract from Dissertation, Munich.)—The treatment is entirely theoretical, and those interested should refer to the original pages. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1093. *Influence of Temperature and of Light on the Conductivity of a Phosphorescent Body (CaS).* **P. Vaillant.** (Comptes Rendus, 154. pp. 867–869, April 1, 1912.)—The author has previously indicated the considerable variation of conductivity which CaS appears to exhibit under the action of light [see Abstract No. 202 (1912)]. But in the earlier experiments the sulphide was stuck by means of glue, and this might have affected the results considerably. A modification of the apparatus has shown that the only effect of the glue is to increase the conductivity without affecting in any appreciable manner the law of variation. A thin plate of the sulphide, of at the most 1 mm. thickness, was placed between two conducting electrodes, one of which was rendered transparent and received the light employed in the investigation. The results obtained were qualitatively the same as before. Quantitatively they varied with the thickness of the layer of sulphide, the greater or less transparence of the electrode, and in fact with each arrangement of the apparatus. Generally the conductivity increases under the action of the light up to a maximum, then diminishes. In the dark it diminishes continuously, and in 4 or 5 days it completely changes in order of magnitude, the apparatus in general becoming unusable. For a given apparatus, the relative variations of conductivity are independent of the initial conductivity. A thermo-couple was used to investigate the temperature effect. Taking the variations of temperature as abscissæ, the relative variations of conductivity as ordinates, the curve, at first convex on the side of the abscissæ, becomes fairly rapidly a straight line, then incurves when the conductivity gets near its maximum. The form of the first portion of the curve can be explained by the fact that, in the first moments of the illumination, the temperature of the junction and the mean temperature of the sulphide do not correspond. It would seem permissible to attribute the observed variations of resistance to the unique variations of temperature. This hypothesis is altogether contradicted by the following facts: (i) The conductivity always passes a maximum and then decreases rapidly, though the temperature may be stationary or even still increasing. (ii) The slope of the rectilinear portion of the curve varies with the source of light used and with the distance of that source. (iii) The slope is considerably modified by the interposition, between the source and the resistance, of a vessel filled with water, which absorbs the long wave-lengths. (iv) The rectilinear portion of the curve when produced never passes through the origin. (v) When the light is cut off, the temperature and the conductivity both decrease, but the curve connecting their variations has no relation to the former one, even when the illumination has been of short duration and the substance is very far from its maximum conductivity. In this case it even happens that for several minutes the conductivity continues to increase while the temperature decreases.

A. W.

1094. *Connection between Electric Resistance, Absolute Temperature of Melting-point, and Atomic Volume of Metals.* **A. Stein.** (Phys. Zeitschr. 13. pp. 287–288, April 1, 1912.)—Theory traces all the properties peculiar to solids to their atomic weight, atomic volume, and proper frequency. The aim of the present paper is to establish the connection between electric resistance and those constants. If v = atomic volume, σ = specific resistance per cm. cube, T_s the absolute temperature of melting-point, and T absolute temperature at time of observation, then the quotient of the resistance by the square of the amplitude reduces to the form $\sigma T_s/T_v$. A table shows the value of the quantity (multiplied by 10^6) for 12 metals at T = 291°. With the exception of Ag and Zn the metals can be arranged into three groups. The first contains Cu, Au, Al, Mg, Cd, and Sn with a value of 1·1 about; the second Pb and Th with a value of 2·2 about, *i.e.*, twice the first; and the third Pd and Pt with 6·6 about, *i.e.*, 6 times the first. It appears, therefore, that the relationship $\sigma = nCvT/T_s$, in which C is a constant for all metals and n is a whole number, must be considered to hold good. These results, of course, dc not hold at very low temperatures.

A. E. G.

1095. *The Behaviour of Bismuth, Antimony, and Tellurium with Alternating and Continuous Currents.* **H. Geipel.** (Ann. d. Physik, 38. 1. pp. 149–205, May 7, 1912. Extract from Dissertation, Leipzig.)—Lenard found in Bi, Sb, and Te varying conductivity for continuous currents and alternating currents of period 10,000. Various observers have examined the phenomenon and the author has investigated it especially in the case of Bi in a magnetic field, but also for Sb, Te, and some other metals. He finds that in the three metals named a second e.m.f. remains after the cutting-off of a current flowing through the wire. In the case of Sb outside a magnetic field, the remaining e.m.f. is the same as that of the impressed current, is proportional to the strength of this current and to the length of the wire, and depends on the crystalline structure of the wire. The curve showing the relation between this after-effect and time, falls at first quickly, then more slowly; it is thus not expressed by an exponential function. A magnetic field strengthens the remaining e.m.f. in a small degree. In Sb the effect is lessened by a magnetic field whose lines of force are at right angles to the length of the wire. The effect is increased in Bi by a longitudinal magnetic field. With Bi as with Sb in a transverse magnetic field, the remaining e.m.f. appears, but soon falls off. The potential-fall is in the opposite direction to that of the current sent through the wire. A similar behaviour is observed in the case of tellurium. The cause of the phenomena observed appears to be connected with the existence of layers of some medium between different portions of the pure metal. J. J. S.

1096. *Resistivity of Magnesium.* **E. F. Northrup.** (Metallurgical and Chem. Engin. 10. pp. 277–278, May, 1912.)—Measurements were made of the resistivity and temperature-coefficient of a rectangular bar of magnesium metal between the temperatures 20° and 155° C. The method used was that of the Kelvin double bridge, and the resistivity at 20° was found to be $4{\cdot}56_9 \times 10^{-6}$ ohms-cm. This value it is highly probable is correct within 1/5 per cent. J. J. S.

1097. *Dielectric Constant of Liquid Arsine.* **H. Schlundt** and **O. C. Schaefer.** (Journ. Phys. Chem. 16. pp. 258–254, March, 1912.)—The following table gives the dielectric constants of this group of liquid hydrides at −50° and 15°:—

	−50°	15°
Ammonia	22·7	15·9
Phosphine	2·6	2·88
Arsine	2·58	2·05
Stibine	2·58	1·81

T. M. L.

1098. *E.M.F. due to Flow through Capillary Tubes.* **L. Riéty.** (Comptes Rendus, 154. pp. 1205–1217, May 6, 1912.)—In continuation of his experiments [see Abstract No. 1286 (1911)] the author confirms Quincke's observation that the e.m.f. decreases to a limit when the experiments are continued for a day or more. These limits are, per pressure-difference of 1 atmo. (up to 800 atmos. tried), in the case of copper sulphate: $6{\cdot}5 \times 10^{-6}$ volt in solutions of 1 gm.-mol. per litre, and 47 in solutions 1/40 gm.-mol. per litre; zinc sulphate gives higher values throughout, 225 maximum (all in 10^{-6} volt). The potential depends upon the pressure and concentration, not upon the length and cross-section of the tube. In the case of the sulphates the current direction is the same as the direction of flow of liquid, *i.e.,* the liquid has the higher potential at its exit, and addition of sulphuric acid to the electrolyte does not alter the sense of the current. In the case of nitrates and chlorides (Cu, Zn), the current direction is opposed to the flow of liquid. H. B.

1099. *Metal-Selenide Couples.* **H. Pélabon.** (Comptes Rendus, 154. pp. 1414–1416, May 28, 1912.)—Certain metals fuse in selenium under formation of compounds. The cooled mass separates into an upper layer of Se and a lower layer of selenium compounds. The author investigates the compositions of these compounds by forming couples of a metal rod (Ag) in its salt ($AgNO_3$), the other electrode being a bar of the compound with selenium. The p.d.'s support the view that the only selenides formed are Ag_2Se, PbSe, Cu_2Se, and SnSe and Sn_2Se. The pure metal was always the negative pole. H. B.

1100. *Stratification and Capacity of Carborundum. Electrical Properties of Crystals.* **G. W. Pierce** and **R. D. Evans.** (Amer. Acad., Proc. 47. No. 21.

pp. 793–822, March, 1912.)—The following is the authors' summary of conclusions: (1) An electrostatic capacity is found in carborundum. (2) The capacity measurements with two specimens are given for different voltage and different frequencies of charge and discharge. The capacity of one of the specimens was about 0·006 mfd.; that of the other about 0·022 mfd. (3) With specimen I. a leak, different in different directions of charge and not obeying Ohm's law, made the measurements uncertain of accurate interpretation. (4) Specimen II. was practically non-leaky, but showed incompleteness of charge and discharge such as would be obtained with a high resistance (120,000 ohms) in the circuit. A reduction of the observation on the assumption of incomplete charge and discharge gives a capacity which for voltages not zero is different in the two opposite directions of charge. In one direction of charge the capacity increases, and in the other decreases, with increase of applied voltage. (5) The existence of capacity in the crystal was found to be due to the existence of numerous alternate conducting and insulating strata within the crystal. These strata are visible with vertical illumination and moderate magnification. (7) The action of carborundum as a detector for electric waves and as a rectifier for electric currents is independent of its action as a capacity. But it will only detect or rectify if contact is made to one or more of the conducting strata. It may act as detector when no capacity is measurable; but, on the other hand, whenever capacity is found, rectification and detector action are also found. L. H. W.

1101. *Measurement of the Peltier E.M.F.* **H. C. Barker.** (Phys. Rev. 34. pp. 224–225, March, 1912.)—The Peltier e.m.f. for nickel-copper was measured by the method devised by the author [see Abstract No. 188 (1911)]. The mean of twelve results was: $P = 6{\cdot}74 \times 10^{-3}$ volt at 28·9°. In a second series of determinations the mean of eleven results was $P = 6{\cdot}73 \times 10^{-3}$ volt at 29·1°. J. J. S.

1102. *Thermo-E.M.F. of the Nernst Filament.* **J. S. Shearer.** (Phys. Rev. 34. pp. 238–239, March, 1912. Abstract of paper read before the Amer. Physical Soc., Dec., 1911.)—Platinum and platinum-rhodium wires were fused to the ends of a Nernst filament and passed through two-bore fire-clay tubes. These were in turn slipped inside a thin-walled quartz tube for protection. The tube could be slid along in a platinum furnace with the windings bunched in the middle so that the temperature gradient was fairly steep. The e.m.f.'s of the two thermo-couples and that of the filament against Pt were measured in succession by a potentiometer. The results for a 220-volt filament for a range of temperatures are given. The values for the highest and lowest temperatures used are as follows: $\Delta t^\circ = 20$, ΔE volts $= 0{\cdot}0080$, $\Delta E/\Delta t = 0{\cdot}00040$, $t_1^\circ + t^\circ/2 = 1425^\circ$ C., $\Delta t^\circ = 440$, $\Delta E = 0{\cdot}1860$, $\Delta E/\Delta t = 0{\cdot}00041$, $t_1^\circ + t^\circ/2 = 980^\circ$. Thus the thermoelectric power is more than forty times that of Pt — Pt-Rh for the same temperature-interval. J. J. S.

1103. *Generating Unidirectional Current-impulses for Röntgen-ray Purposes.* **H. Boas.** (Deutsch. Phys. Gesell., Verh. 13. 16. pp. 651–664, Aug. 30, 1911.)—The author describes a form of alternator which is able to give a voltage curve of asymmetric wave-form, consisting of a short high peak on the one side and of a practically straight line near the axis of abscissæ on the other side. The generator is built up as a motor-generator set and can furnish 5 kw. on the a.c. side. When stepped up by means of a transformer the current impulses from such a generator are stated to give very perfect results in X-ray work. L. H. W.

1104. *Electrical Resistance of Xylol-Alcohol Mixtures.* **N. Campbell.** (Phil. Mag. 23. pp. 668–670, April, 1912.)—In a previous paper [Abstract No. 1502 (1911)] the author described certain liquid resistances which may be used for the same purposes as the resistances of ionised air generally associated with the name of Bronson. The present paper contains an account of further investigations into their properties. The resistances may be made with commercial xylol and absolute alcohol which has been distilled from lime. The most convenient mixture to use contains 1 part of alcohol to 10 parts of xylol, the specific resistance of this mixture being of the order 10^{-10} ohms. The resistance of the mixture has a large temperature coefficient, the resistance increasing with temperature. Temperatures below 15° C. should not be used owing to the difficulty of obtaining consistent readings. E. M.

1105. *A Sensitive Black-body Vacuum Thermo-junction.* **A. H. Pfund.** (Phys. Rev. 34. pp. 228–230, March, 1912. Abstract of paper read before the Amer. Physical Soc., Dec., 1911.)—The metals used in the construction of thermo-junctions were the Bi alloys of Hutchins. Fine filaments of metal prepared from the two alloys were embedded in a very thin disc (about 1 mm. in diam.), obtained by flattening a globule of low-melting-point solder. Fine copper wires previously tinned were soldered to the free ends of the filaments, thus completing the junction. When the little discs had been blackened, the middle one was mounted at the centre of a small spherical mirror, which consisted of two hemispherical portions. The following data were obtained from a thermo-junction which was only about half as sensitive as some which have been tested :—Dimensions of each filament, $0·01 \times 0·15 \times 5·0$ mm. ; diam. of centre disc, 1 mm. ; total resistance, 5 ohms. d'Arsonval galvanometer of 7 ohms resistance ; working sensibility, 2×10^{-9} amp. Radiation from a standard candle at 1 m., passing through a rock-salt plate 1 mm. thick gave rise to the following galvanometer deflections. (1) Junction in air without reflecting enclosure : deflection, 16 mm. (2) Junction in air with reflecting enclosure : deflection, 17 mm. (3) Junction in vacuum with reflecting enclosure : deflection, 210 mm. The sensibility was increased more than 13 times. Previous experiments showed that the evacuation alone produced only a 5–6 fold increase. The convection losses of the heated junction are much greater than the radiation losses ; hence, as long as the junctions are surrounded by air a reflecting enclosure can add but little to the sensibility. A method is described of obtaining a moderately high vacuum free from mercury vapour without the use of liquid air, by means of a charcoal tube. J. J. S.

1106. *Theory of the Galvano-magnetic and Thermomagnetic Effects.* **Z. de Thullie.** (Acad. Sci. Cracovie, Bull. 2a. pp. 59–80, Jan., and pp. 81–85, Feb., 1912.)

1107. *Electrical Properties of the Aluminium Alloys.* **W. Broniewski.** (Thèses Présentées à la Faculté des Sciences de Paris, Ser. A. No. 676. pp. 1–139, 1911.)—The author in this monograph sets out more fully the results published by him at various times relating to the electrical conductivity, temperature-coefficient, and thermo-electric power of the alloys of aluminium with the metals Zn, Sn, Bi, Mg, Ag, Cu, Fe, Mn, and Ni. L. H. W.

1108. *Simplified Electrometer Theory.* **R. Beattie.** (Electrician, 69. pp. 233–234, May 17, 1912.)—The conception of an electrostatic control is extended to the case in which both quadrants are either insulated or connected with condensers [see Abstract No. **1497** (**1910**)], and a working formula for the instrument is obtained. G. E. A.

ALTERNATING CURRENTS AND MAGNETISM.

1109. *Variation of Magnetic Susceptibility with Temperature.* **A. E. Oxley.** (Cambridge Phil. Soc., Proc. 16. No. 6. pp. 486–490, April 22, 1912.)—Curie found that when the temperature is varied diamagnetic substances behave differently from paramagnetic substances, and recently Curie's laws have been widely generalised by Langevin, Weiss, and others. Du Bois and Honda, however [see Abstracts Nos. 786 and 1684 (1910)], have investigated the temperature-susceptibility curves of about 50 elements, and have come to the conclusion that Langevin's theory is unsound. The author attempts to reconcile the observations of Du Bois and Honda with Curie's laws on the assumption that the latter are true for substances composed of simple molecules. He shows that in the case of a magnetic complex formed of an aggregate of molecules $d\chi/d\theta$ may be positive or negative according to the manner in which the groups break up on variation of the temperature, and so it furnishes no criterion as to the validity of Curie's laws. ($\chi =$ susceptibility, $\theta =$ absolute temperature.) A. D. R.

1110. *Joule-effect and Magnetic Permeability of Steel.* **S. R. Williams.** (Phys. Rev. 34. pp. 258–267, April, 1912. Paper read before the Amer. Physical Soc., Dec. 29, 1911.)—In a previous paper [Abstract No. 790 (1911)] the author described experiments showing that the permeability of steel had a decided influence on the magnetostrictive effects. He has now investigated the Joule-effect in relation to the permeability in the case of three rods and one tube of steel. The general arrangement of the apparatus was the same as in the previous experiments, but a photographic method was introduced to record the changes in the length of the 80 cm. long specimens. This allowed the readings to be taken with much greater rapidity, and so the magnetising field could be applied by means of a solenoid without the current having to be kept on so long that heating effects vitiated the results. Curves are given for the Joule-effect as dependent on the permeability and on the induction. The max. elongation occurs at a field strength not far from that at which the knee of the induction curve is found. It is pointed out that the results are in harmony with the theory that magnetisation is due to the orientation of elongated elementary magnets which possess permeability. A. D. R.

1111. *Magnetisation of Alloys of Nickel and Cobalt.* **O. Bloch.** (Archives des Sciences, 33. pp. 293–308, April, 1912.)—A series of ellipsoids of various percentages of Ni and Co were tested below and above the critical temperature by methods which have been already described [see Abstracts Nos. 1930 (1907); 531 (1911)]. Among the results are the following :—Alloys of Ni with Co behave magnetically like a simple series of solid solutions. The variation of magnetic moment for absolute saturation, *i.e.*, saturation calculated for absolute zero, is a linear function of the percentage weight of either metal present. The Curie constant and the coefficient of the molecular field [see Abstract No. 1930 (1907)] are also linear functions of the percentage. The temperature of loss of magnetisation with no external field varies with the percentage according to a parabolic law. The existence of an aliquot part common to the magnetic moments per gm.-molecule of the elements is verified, and also the numerical value of the magneton-gramme already found [see Abstracts Nos. 529, 791 (1911)]. The number of magnetons in cobalt is expressed by a whole number. G. E. A.

1112. *Permanent Magnetism of Copper.* **J. G. Gray** and **A. D. Ross.** (Phys. Zeitschr. 13. pp. 404–407, May 1, 1912.)—With regard to the authors' observations of residual magnetism in nearly pure copper [see Abstract No. 588 (1909)] they point out that Behsen's suggestions [see Abstract No. 218 (1912)] will not explain the anomalous behaviour of the specimens. The thermal treatment involved in the preparation of the permanent magnets was not such as would cause the reduction of oxide impurity required on Behsen's hypothesis. They consider that the observations may be explained on the assumption that the trace of iron present in some of the bars occurred in the form of a solid solution which was more magnetic than would be expected merely from the percentage iron-content, on account of the feeble interaction between the widely-separated iron molecules. The quenching would probably result in an increase in the frictional force opposing the rotation of the magnetic groups, and would so tend towards increased retentivity. A trace of Ni which was present would also occur as a Cu-rich solid solution, and this alloy, while non-magnetic at room temperature, is magnetic at the temperature of liquid air. A. D. R.

1113. *Thermomagnetic Properties of the Elements.* **M. Owen.** (Ann. d. Physik, 37. 4. pp. 657–699, March 26, 1912. From the Bosscha Laborat.)—The paper—which does not lend itself to reproduction in abstract—gives details of the methods and results of an investigation of the susceptibility of fairly pure specimens of nearly 60 elements, as tested at room temperature, at the temperature of liquid air, and at high temperatures. The peculiarities of each element are considered in detail in reference to the position occupied by the element in the periodic system, and curves are given of the specific susceptibility as a function of the atomic weight. The temperature variations in the magnetic properties are likewise discussed, and the elements are tabulated according to the qualitative temperature effects found in the magnetism. These results are in extension of those of Honda [see Abstract No. 1516 (1910)]. A striking peculiarity is that there are very few diamagnetic elements, the numerical value of whose susceptibility increases with increase of temperature. A. D. R.

1114. *Subsequent Magnetisation of Iron.* **A. Bernini.** (N. Cimento, 3. Ser. 6. pp. 295–307, April, 1912.)—The paper is a continuation of a previous one [see Abstract No. 590 (1912)]. Using the same experimental arrangement, further specimens are examined and the previous conclusions confirmed. S. G. S

RADIOLOGY AND ELECTROPHYSIOLOGY.

1115. *Dubilier's High-potential Apparatus.* (Electrician, 68. pp. 923–924, March 15, 1912.)—Comprises two transformers, a quenched-spark oscillator and a small condenser, and is fitted into a box measuring 15 in. × 9 in. × 8 in.; weight complete 15 lbs. A heavy discharge over 6 in. can be obtained, and with a primary current of 2 amps. at 110 volts large X-ray tubes can be operated. The cost is stated to be about one-tenth that of other machines. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1116. *Canadium: a supposed New Element.* **A. G. French.** (Chem. News, 104. p. 288, Dec. 15, 1911. Reprint from *Glasgow Herald*, Dec. 5, 1911.)—Gives a few particulars relating to what is claimed by the author to be a new element, probably of the platinum group, which he has found in a platinum mine in Canada. The metal is white and lustrous, melts at about the same temperature as silver, and is electro-negative to the latter in dilute acid solution. A few chemical test results are stated and the behaviour in the blow-pipe is referred to, but nothing is said as to specific gravity, hardness, or other definite properties. L. H. W

1117. *Atomic Weight of Radium.* **R. Whytlaw-Gray** and **W. Ramsay.** (Roy. Soc., Proc. Ser. A. 86. pp. 270–290, March 26, 1912.)—The final value arrived at is 226·36 for the atomic weight of Ra, thus confirming Mme. Curie's results but disagreeing with Hönigschmid's. L. H. W.

1118. *Colour and Constitution of Water.* **J. Duclaux** and **E. Wollman.** (Journ. de Physique, 2. Ser. 5. pp. 263–268, April, 1912.)—The colour of 6 m. of water at 0° C. is equal to that of 2 cm. of a 4 per cent. solution of $CuSO_4 . 5H_2O$. At 85° the colour is more green, and is equal to that of 2 cm. of 1·60 per cent. $CuSO_4 . 5H_2O$ plus 2 cm. of 0·025 per cent. $K_2Cr_2O_7$. A similar change of colour is produced by the addition of colourless salts, which demand a diminution in the quantity of copper sulphate and an addition of dichromate in the comparison cells, to restore the balance previously existing. Both changes can be explained as due to the conversion of blue dissolved "ice-molecules" into "water-molecules" differing perceptibly in tint. T. M. L.

1119. *Active Modification of Nitrogen produced by the Electric Discharge.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 86. pp. 262–269, March 26, 1912.)—The author arrives at the following conclusions: (1) Active nitrogen emits its energy more quickly and reverts sooner to ordinary nitrogen if it is cooled. This is apparently a unique instance of a chemical change accelerated by cooling. (2) If the glowing gas is compressed to small volume it flashes out with great brilliance, and exhausts itself in so doing. This proves that the glow-transformation is polymolecular, *i.e.* that more than one molecule must take part in it. (3) Active nitrogen may revert to ordinary nitrogen in two distinct ways. One of those is a volume change accompanied by glow, the other a surface action of the walls of the vessel without glow. This is analogous to the behaviour of oxy-hydrogen gas in its transformation to water, which may be a surface or volume effect, according to circumstances. [See Abstracts Nos. 570, 596 (1912).] L. H. W.

1120. *Decomposition of Water by Magnesium.* **A. W. Knapp.** (Chem. News, 105. p. 253, May 31, 1912.)—Magnesium does not appear to decompose water at ordinary temperature. But when magnesium powder is added to 10 times its weight of water and a trace of palladious chloride (which is reduced to metal by the Mg), the temperature rises to boiling, and much hydrogen is evolved. The Pd first accelerates the decomposition of water, and afterwards its formation; for rising on the bubble films it causes spontaneous ignition of the hydrogen. H. B.

1121. *Permeability of Iron to Hydrogen.* **G. Charpy** and **S. Bonnerot.** (Comptes Rendus, 154. pp. 592–594, Feb. 26, 1912.)—It has been known for a long time that iron acts as a semi-permeable membrane towards a gas containing hydrogen, but the fact that iron evolves an indefinite amount of gas when heated *in vacuo* has made an exact study of the subject very difficult. The authors have studied the phenomena of the diffusion of hydrogen at high and low temperatures with a view to obtaining some light on occlusion and osmosis. Below 325° C. penetration by hydrogen does not seem to take place, but the rate increases with the temperature until it is very rapid above 750° C. The rate of penetration depends upon the thickness of the membrane. Experiments on osmosis (electrolytic production of hydrogen in contact with the metal) showed that, other things being equal, the rate of penetration depends upon the nature of the metal and the thickness of the membrane. With copper no penetration occurs, and even with iron and steel osmosis no longer occurs when the membrane is placed more than a few mm. from the negative electrode. The internal pressure appears to rise above 14 atmos., and the general results indicate that hydrogen forms a solution in the iron and acquires a special chemical activity during the passage. F. C. A. H. L.

1122. *Nature of the Transformation of Lead-Tin Alloys occurring in the Solid State.* **D. Mazzotto.** (Internat. Zeitschr. f. Metallographie, 1. pp. 289–352, 1911.)—The reversible transformation occurring in Pb-Sn alloys was first observed by the author in 1883, but in view of the lack of agreement between numerous workers [see Abstracts Nos. 322, 727, and 1782 (1909)] as to the nature of the change taking place, he has resumed the study of the phenomenon. The method adopted was to prepare an alloy containing 83·8 per cent. Sn and to compare its rate of cooling with that of mercury under identical conditions. From this the heat equivalent of the transformation can readily be calculated. The cooling of the alloy was observed in 0° C. after annealing for short, medium, and prolonged periods at 145°, 155°, 165°, 175°, 180°, 183°, and 190° C. both on heating and cooling. Thermal treatment affects both the temperature and intensity of the transformation. Annealing confines the change to narrower limits, which are elevated by increasing the temperature of annealing. The max. values of both temperature and intensity are obtained by annealing at the eutectic temperature. Annealing during heating or cooling tends to produce the same ultimate effect. At a certain definite temperature below the eutectic point annealing has no effect on the transformation. Below this point the intensity of the change decreases, above it increases. The temperature in question is the mean temperature of saturation of the existing crystals of solid solution. The author's earlier experiments showed that the transformation attained its max. temperature and intensity at the concentration of the saturated solid solution, *i.e.*, 18 per cent. Sn. Above this percentage of tin the temperature of the change remains constant, but its intensity gradually diminishes. The author considers that these facts are adequately explained by omitting the allotropic field from Rosenhain and Tucker's diagram [see Abstract No. 322 (1909)]. Below the eutectic temperature the solubility of tin in lead diminishes rapidly, with the result that tin is thrown out of solution with

a considerable evolution of heat. That the change does not complete itself at or just below the eutectic point is ascribed partly to the appearance of supersaturation and to the effect of the unsaturated crystals deposited during solidification. Similar phenomena should occur in all alloys forming solid solutions, and have been observed in Bi-Sn, Sn-Tl, Sn-Cd, and Sn-Zn alloys.
F. C. A. H. L.

1123. *Physical and Chemical Properties of some Organic Amalgams.* **H. N. McCoy** and **F. L. West.** (Journ. Phys. Chem. 16. pp. 261–286, April, 1912.)—By an improved method of working, tetramethylammonium amalgam was obtained in solid form; determinations were made of its density and electrical resistance. The amalgam causes the discharge of a positively-charged electroscope, but a negatively-charged electroscope is not discharged. The amalgam decomposes very slowly at 0° but quite rapidly at 25° according to the equation: $4Hg_x(CH_3)_4N \longrightarrow 4(CH_3)_3N + 2CH_4 + C_2H_4 + XHg$. The method of preparation and the properties of monomethylammonium amalgam were also studied.
T. M. L.

1124. *The Two Limiting Volumes of Liquids at the Absolute Zero of Temperature and at Infinite Pressure.* **F. Körber.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 1. pp. 1–30, 1912. Ann. d. Physik, 37. 5. pp. 1014–1045, April 16, 1912.)—Equations are given for determining by extrapolation the volume of a liquid (1) at zero temperature and atmospheric pressure, and (2) at infinite pressure and at temperatures ranging from 0 to 50° without producing any marked alteration in the limiting values. The extrapolated values were as follows:—

Substance.	Limiting Volumes.		
	$T = 0, p = 1.$	$p = \infty.$	Diff.
Ethyl ether	0·751	0·694	0·057
Ethyl bromide	0·766	0·704	0·062
Phosphorus trichloride	0·770	0·730	0·040
Carbon disulphide	0·770	0·720	0·050
Acetone	0·747	0·701	0·046
Allyl alcohol	0·756	0·748	0·008
Ethyl alcohol	0·758	0·730	0·022
Methyl alcohol	0·729	0·722	0·007

The volumes at zero temperature are uniformly higher than those at infinite pressure—a conclusion that is in accord with current views as to the compressibility of the molecules themselves under extreme pressures. T. M. L.

1125. *Correlation of Physical Properties of Solutions.* III. *Ionic-moduli of Density in Water.* **A. Heydweiller.** (Ann. d. Physik, 37. 4. pp. 739–771, March 26, 1912.)—The density moduli of univalent monatomic atoms are closely proportional to a series of integral ratios, *e.g.*—

	H	Li	Na	K	Rb	Ag	Cs	F	Cl	Br	I
0·35 ×	—3	—1	4	6	18	29	30	9	9	19	29.

T. M. L.

1126. *Dissolution of Copper in Water.* **J. Pionchon.** (Comptes Rendus, 154. pp. 865–867, April 1, 1912.)—Continuing his investigation of the effects of movement on electrodes [see Abstract No. 1412 (1911)], the author dips two foils of copper, 1·25 cm.^{2} surface, into ordinary tap-water. As long as they are kept still, hardly any p.d. is observed. When one of the foils is shaken by sharp blows, it becomes electro-negative; when the blows are continued, the effect weakens and ceases after 36 hours, but it reappears when the water is renewed. The effect is ascribed to a solution of copper (struck electrode) in water in the sense of Nernst, and the author confirms this view by experimenting with samples of the same water, in some of which copper-foil had been kept for at least two days. H. B.

1127. *Properties of Salt Solutions in Relation to the Ionic Theory.* III. *Electrical Conductance.* **A. A. Noyes** and **K. G. Falk.** (Amer. Chem. Soc., Journ. 34. pp. 454–485, April, 1912.)—The chief subject considered in this paper is the variation with concentration of the equivalent conductivity Λ of 28 salts, and more especially of their "intrinsic conductivities" $\Lambda\eta/\eta_0$, in which a correction is made for the changing viscosity of the liquid. A table is given showing the deviations of the intrinsic conductivities from those calculated from Kohlrausch's equation $\Lambda\eta/\eta_0 = B - KC^{1/3}$. A second table shows that the equation $\log \Lambda\eta/\eta_0 = \log B - KC^{1/3}$ is no better for uni-univalent salts, but is a considerable improvement in the case of uni-bivalent salts; a still better agreement is found in the latter case when the equation $\Lambda\eta/\eta_0 = B - KC^n$ is used with an index 0·20 instead of 0·33. Cadmium chloride and nitrate give specially large deviations, probably because they give rise to complex ions. T. M. L.

1128. *Osmometry of Saline Solutions and the Theory of Arrhenius.* **E. Fouard.** (Journ. de Physique, 2. Ser. 5. pp. 269–281, April, 1912.)—The author attempts to measure the osmotic pressure of saline solutions by producing a transient balance against a sugar solution separated by a membrane of collodion. He regards the semi-permeable membrane as a fiction, and finds in this obsolete statement an excuse for using a membrane which is in no sense semi-permeable. His results naturally disagree with those of workers using more orthodox methods. T. M. L.

1129. *Properties of Salt Solutions in Relation to the Ionic Theory.* IV. *Comparison of the Ionisation Values derived from the Freezing-point Lowering and from the Conductance Ratio.* **A. A. Noyes** and **K. G. Falk.** (Amer. Chem. Soc., Journ. 34. pp. 485–489, April, 1912.)—A comparison of the two sets of ionisation values at concentrations between 20 and 100 millinormal inclusive shows the following deviations. KCl, NH_4Cl, and KBr: less than 1% of the ionisation value; NaCl and CsCl: 1 to 2%; LiCl: 4 to 6%. $NaNO_3$ and KNO_3: 3 to 5% (but the probable accuracy of the freezing-point results is in these cases small); $KClO_3$ and $KBrO_3$: 2 to 4%; KIO_3: 2 to 7%, increasing with the concentration; $NaIO_3$: practically zero up to 50, 8·5% at 100 millinormal. HCl: 0·8 to 1·2% (yet the values are 5 to 10% greater than those for neutral salts); $BaCl_2$: 1 to 4%, increasing with the concentration; $CaCl_2$ and $MgCl_2$: 3 to 9%, increasing with the concentration. $CdCl_2$, $CdBr_2$, CdI_2, and $Cd(NO_3)_2$: much larger deviations than with the other uni-bivalent salts. $Pb(NO_3)_2$ and K_2SO_4: not more than 2%, even up to 200 millinormal; Na_2SO_4: about 5%; $MgSO_4$, $CuSO_4$, $ZnSO_4$, $CdSO_4$: very large deviations; $K_4Fe(CN)_6$: 7 to 8%. The two methods give ionisation values which for most uni-univalent substances agree with each other within 2% up to 0·1 normal; the same is true of the uni-bivalent salts, potassium sulphate, and lead nitrate, even up to 0·2 normal. The halides and sulphates of bivalent metals (and also lithium chloride and sodium sulphate), on the other hand, show, as a rule, much larger deviations than this at 0·1 and 0·2 normal. Most of the deviations may be attributed to the formation of intermediate or of complex ions. T. M. L.

1130. *New Method for the Quantitative Analysis of Solutions by Precise Thermometry.* **T. W. Richards** and **J. W. Shipley.** (Amer. Chem. Soc., Journ. 34. pp. 599–608, May, 1912.)—The method depends upon noting the precise temperature at which the unknown solution attains exactly the same density as a given, previously calibrated, solid float of glass or quartz. Then the relation between the concentration and the temperature having been previously determined, the concentration of any given solution can be found. The sensitiveness of the method is indicated by the following observation. A buoy-shaped or fish-shaped glass float, of not more than 5 c.cm. displacement, will distinctly change from floating to sinking when the temperature of the liquid is raised 0·001°, if just on the equilibrium point. This corresponds with a change of density of about 0·000001 in the case of most organic solvents, or about 0·0000002 in aqueous solutions. If a 1 per cent. solution of a salt has a density of 1·01 compared with water at the same temperature, this degree of sensitiveness should enable us to estimate the amount of salt present to within 0·002 per cent. The method may be used not only to analyse solutions, but also to calibrate thermometers, as well as to prepare exact solutions of any desired concentration. The coefficient of expansion of the solid float may also be determined with its help. T. S. P.

1131. *Component Values of the E.M.F. of a Voltaic Cell. Theory of the Cell.* **G. Guglielmo.** (Accad. Lincei, Atti, 21. pp. 194–201, Feb. 4, 1912.)—From the formula $V = (C - c)/e$, already established [Abstract No. 967 (1912)], it may be deduced that (1) there is no very appreciable p.d. at the points of contact of two metals in a voltaic cell, and (2) any metal in contact with a solution of any of its salts has a potential lower than that of the solution. Further experiments with ZnI_2 and ZnF_2 confirm the conclusion that the pressure of the electropositive ions in a metal increases with the oxidisability of the metal, or with increase in its heat of combination with oxygen, chlorine, &c. W. H. Si.

1132. *Electrochemistry of Radio-active Bodies.* **G. v. Hevesy.** (Phil. Mag. 23. pp. 628–646, April, 1912.)—(1) The general electrochemical properties of radio-active bodies are discussed. It is shown that the deposition of these bodies on Pt electrodes in the ordinary course of electrolysis, or on a metal dipping into an active solution, depends to a large extent on the potential of the electrode. (2) RaB, ThB, and AcB, possess the same electrochemical properties. RaC, ThC, and AcC possess also the same electrochemical properties. With very small electrode potentials C is deposited almost pure; as the electrode potential is increased, the amount of B separated with the C increases also. When $\varepsilon_{(Hg)} = -0{\cdot}6$ volt, B, and C are deposited in equilibrium amount. With higher potentials chiefly B is obtained. (3) A relation exists between the e.m.f. Metal/Solution, and the ratio of B to C deposited on the metal dipping into the solution. When the latter is known, therefore, the former is also known. From this relation, the unknown position of Ta in the series of potentials has been determined. By this method, also, the change of e.m.f. Metal/Water with time of immersion of the metal can be determined. (4) The results of Marsden and Barratt on the branching of the thorium series are consistent with the results obtained on the electrochemical behaviour of ThC. L. H. W.

1133. *Electrolytic Reduction of Niobic (Columbic) Acid.* **F. Ott.** (Zeitschr. Elektrochem. 18. pp. 349–362, May 15, 1912.)—Niobium (columbium) seems to occur with valencies 2, 3, 4, 5, and the compositions of its oxides are uncertain. The reduction of the acid has often been attempted without success, and the electrolytic reduction by the author does not lead to definite results either. By heating the acid with carbon in an electric furnace he obtains some compounds with nitrogen and carbon, over which he passes chlorine at 200° C. The resulting chloride is condensed, dissolved in hydrochloric or sulphuric acid, and electrolysed under exclusion of air in a diaphragm cell with electrodes of Pt, kathode also of lead. The resulting blackish-blue crust could not be analysed. The electrolysis of the fused potassium-columbium oxyfluoride yielded some lower oxide. H. B.

1134. *Electrolytic Reduction of Nitrobenzene.* **E. F. Farnau.** (Journ. Phys. Chem. 16. pp. 249–252, March, 1912.)—H. C. Allen (Ibid. 16. p. 89), having shown that nitrobenzene can chemically be reduced in an alkaline solution of ferrosulphate and sodium hydroxide, the author effects the reduction electrolytically without the aid of a diaphragm, in an iron pipe (kathode) stirred at 1500 revs. per min. by a steel shaft about which iron wire is twisted (anode). The electrolyte consists of sodium sulphate and nitrobenzene. Both the ferrous hydrate, which is oxidised to ferric hydrate, and the hydrogen take part in its reduction, which at 25° or 35° practically yields only aniline. H. B.

1135. *Electrolytic Preparation of Trivalent Vanadium Salts.* **E. Renschler.** (Zeitschr. Elektrochem. 18. p. 137, Feb. 15, 1912.)—Bültemann showed in 1904 that green trivalent vanadium salts, like vanadium-ammonium alum, could be obtained by reducing the ammonium metavanadate chemically (in H_2SO_4 and SO_2) to the blue quadrivalent salt and then electrolytically to the green trivalent compound. The author effects the whole reductions electrolytically in a cell containing strong sulphuric acid with a porous diaphragm and lead-foil cylinders as electrodes under good stirring. When the electrolysis is continued too far, a violet solution is produced in which the vanadium is divalent. H. B.

1136. *Adsorption.* **A. Grumbach.** (Journ. de Physique, 2. Ser. 5. pp. 288–297, April, and pp. 385–392, May, 1912.)—Treats the thermodynamical theory of adsorption with an application to contact electricity. [See Abstract No. 809 (1911).] E. H. B.

1137. *Haber's Theory of Heat of Reactions.* **E. Wertheimer.** (Deutsch. Phys. Gesell., Verh. 14. 8. pp. 431–437, April 30, 1912.)—Deals with the heat involved in chemical processes as a function of the proper frequencies of the reacting substances. [See Abstracts Nos. 1379 (1911) and 153 (1912).] E. H. B.

1138. *Cementation of Iron by Solid Carbon.* **G. Charpy and S. Bonnerot.** (Rev. de Métallurgie, 9. pp. 305–320, May, 1912.)—A more detailed description of the work dealt with in Abstract No. 96 (1912). F. C. A. H. L.